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Analysis of researching amphibian numbers in Alberta (RANA) Project - amphibian captures at pitfall trapping sites 1997-2008

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Brian Eaton and Michelle Hiltz

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EXECUTIVE SUMMARY

Declines in amphibian populations at local, regional, and global scales have focused attention on this group of vertebrates. Of the 10 amphibian species in Alberta, seven are listed as "at risk" by provincial or federal agencies. In response to concern about amphibians populations, and a lack of amphibian monitoring in the province, the Researching Amphibian Numbers in Alberta (RANA) program was initiated in 1997 with two main objectives: (1) to collect long-term information on amphibian populations in Alberta, and (2) to increase public awareness of the importance of amphibians and wetland conservation. Seven RANA sites were established in Alberta and monitored using pitfall trapping at a designated pond within each study area. Here we present an analysis of pitfall trapping data collected between 1997 to 2008.

During the RANA project a total of 67,299 trap nights were accumulated and a total of 15,051 amphibians of eight different species were captured. Amphibian populations sampled during the RANA project experienced wide fluctuations in relative abundance, ranging from years when a species was not caught at a site at all to years when large numbers of young-of-the-year (YOY) were produced. Trends in abundance were negative for the majority of populations sampled during the RANA project; however, most of the trends detected (both positive and negative) were only marginally significant. This pattern is common in amphibians, where periodic years of high recruitment, and dispersal and immigration, help maintain individual populations, which generally experience relatively low recruitment levels.

There was no relationship between breeding effort at a RANA site and the production of YOY in the same year, nor between how many YOY were produced in one year and the number of breeding adults in the following two years. There was no discernible pattern in trends in mean size (as measured by snout-to-vent length) of either adults or YOY over time.

Because the life cycles of amphibians are complex, and parameters such as size and survival are influenced by multiple factors, it is often difficult to determine what drives patterns in natural populations of these animals without intensive research. However, several conclusions can be drawn from the scientific literature: (1) both aquatic and terrestrial habitats play a role in influencing survival of individual amphibians and the persistence of a population at a site, (2) the terrestrial environment is more important in regulating amphibian populations than previously thought, (3) terrestrial use by amphibians differs by species, season, age class, and sex, (4) conservation management for amphibians should include both aquatic and terrestrial habitats, and the quality, distribution and connectivity of these habitats. The RANA project has provided a dataset on natural size and fluctuations of amphibian populations in Alberta, and information

on individual characteristics (e.g. body size) which should prove useful as a baseline for comparison with future work in the province.

1.0 INTRODUCTION

Declines in amphibian populations at local, regional, and global scales (Blaustein et al. 1994; Houlahan et al. 2000; Corser 2001; Carrier and Beebee 2003) have recently focused attention of the scientific community and the public on this group of vertebrates. Of the 10 amphibian species that occur in Alberta, seven are listed at provincial or federal levels (Table 1). Amphibians, including many of the species that occur in Alberta, are currently threatened by many anthropogenic activities (Collins and Storfer 2003), and are considered sensitive indicators of environmental quality (Wake 1991; Blaustein et al. 1994). Because this group of vertebrates naturally experiences pronounced fluctuations in abundance at any given site (Trenham et al. 2003) it is important to track changes in amphibian populations over time and space in order to understand how they are responding to natural and human-induced environmental changes (Storfer 2003). In addition, education is necessary in order to change peoples' attitudes toward conservation and the role they can play in minimizing impacts on their local ecological neighbourhood (Stern et al. 2008).

The Researching Amphibian Numbers in Alberta (RANA) program was initiated in 1997 with two main objectives: (1) to collect long-term information about amphibian populations in Alberta, and (2) to increase public awareness of the importance of amphibians and wetland conservation. Following inception of the program, a total of seven RANA sites were established throughout the province and monitored when personnel were available. Monitoring consisted of pitfall trapping at a designated pond within the study area and/or surveys of a number of ponds in the local region. Although trapping at individual sites within a region only generates limited data on the persistence and distribution of amphibian populations, it does provide an opportunity to collect morphometric data, examine individuals for signs of disease and deformities, and to collect data on the local breeding population. Here we present an analysis of pitfall trapping data collected from 1997 to 2008.

2.0 STUDY AREA

A total of six pitfall monitoring sites were established across Alberta during the RANA project (Figure 1). These were chosen to represent a variety of natural regions (Alberta Environmental Protection 1994): Cypress Hills is located in a unique montane ecosystem within the Grassland Natural Region, Kananaskis (Bow Valley) is located in the Rocky Mountain and Foothills Natural Regions, the Hinton (Athabasca Valley) site was located in the Foothills Natural Region, and the Meanook Biological Research Station, Lesser Slave Lake and Saskatoon Island Provincial Park sites were located in different parts of the Boreal Forest Natural Region. Note that two different sites were used at Kananaskis, as the initial pond dried up in 2001 and was

replaced with a nearby site. Pitfall traps were not used in the Grassland Natural Region during the RANA project, and because this is the only ecoregion in which the Great Plains Toad and the Plains Spadefoot Toad are found in the province, these species were never captured at RANA project pitfall sites (pitfall trapping is inappropriate for these species because of their rain-dependent irruptive behaviour).

The number of RANA project sites where trapping occurred varied across years (Table 2), with the number of sites used in any given year varying from 2 to 6 depending on the availability of resources (e.g. funding, people). Individual sites were used over 4 to 10 years (Table 2); a total of 50 site-years were accumulated over the course of the project. Trapping schedules varied slightly between sites, but traps were generally set during the spring breeding season (May to early June), and in late summer (August to early September) when young-of-the-year (YOY) disperse from the ponds. Young-of-the-year are defined as animals captured in the same year they emerged from their natal ponds; these animals have not yet survived a winter. The Meanook site was only operated from July to mid-August for logistical reasons.

3.0 METHODS

3.1 Trapping

At each RANA site one pond was set up for pitfall trapping, being completely or partially encircled with drift fence and pitfall traps (Figure 2). Drift fences were approximately 40 cm high, and the bottom edge of the fence was buried approximately 10 cm deep to prevent animals passing under the fence (Heyer et al. 1994). In the first years of the RANA project heavy clear plastic, supported by wooden stakes, was used to construct fences; these were eventually replaced with drift fence constructed of silt fencing material, which was more durable and UV stable than the plastic (Enge 1997). Pitfall traps were placed at 10 m intervals on either side of the fence. Traps consisted of two 6-inch plastic flower pots taped together, creating a 12-inch deep trap (Figure 3). Traps were covered by a square of Coroplast™ (Coroplast, Granby, Quebec, 900 rue Cowie Granby, Quebec J2J 1P2; phone: 800-361-5150), a sturdy and water resistant plastic, held above the traps by 6-inch nails. Trap covers ensured that amphibians were protected from excessive exposure to sun, which can lead to desiccation, and prevented flooding from rainfall. Each trap also contained a sponge and/or moss, which was refreshed regularly to provide moisture, a rock that served as a perch or hiding place and a stick protruding past the top of the trap to allow small mammals to escape.

Theoretically, amphibians travelling to or from the pond to breed were intercepted by the drift fence and travelled along the barrier until they fell into a trap, where they remained until they could be processed. In reality, it is highly likely that some trespass occurred (animals moved

under or over the fence), and that the permeability of the fence was different across species. In addition, there were undoubtedly animals that escaped from the pitfall traps; boreal chorus frogs, for example, are semi-arboreal and probably have a high escape rate. This would not be true of toads, which are not particularly good at either climbing or jumping. However, we have assumed here that the rates of trespass and escape were similar across sites and years for each species.

Throughout trapping sessions, traps were checked every 1–2 days. Traps were generally closed during mid-summer when amphibian movement to and from ponds declined. Captured amphibians were identified to species, assigned to a preliminary age class (YOY or adult; age class was later re-evaluated based on data collected at a site; see below for details on how this was done), sexed where possible, weighed, measured (snout-to-vent length; SVL), examined for deformities, parasites, or disease, and released on the opposite side of the fence from which they were captured. Age and sex differentiation was not possible for all species.

Researchers used latex gloves when handling amphibians to avoid contaminating individuals with oils or hand lotion. Animals being released away from the pond were moistened and placed in a sheltered location; extra care was taken on hot days, with individuals released early or late in the day to prevent desiccation. Environmental data were also collected, including air and water temperature, pond pH, water depth, and other ambient conditions. At the Hinton site, long-toed salamanders were marked with Visible Implant Elastomer Tags (VIE; Northwest Marine Technologies, Inc., Shaw Islands, WA, USA), a non-toxic latex material, as part of a mark-recapture study in 2002 and 2003 (refer to Wilkinson and Hanus 2003 for details).

At the end of each trapping session all traps were closed by either pushing the Coroplast™ cover flush to the ground and covering it with dirt and a rock, or by inverting traps to ensure animals could not enter. Also, sections of fence were opened at several locations around the pond to allow animals to pass through.

3.2 Datasets

Data were recorded on field sheets and later entered into Excel spreadsheets. Although a common spreadsheet format was used for entering the data from all sites, there were variations in the way data were recorded and entered across sites and years because different personnel were involved. To allow data analysis and to improve consistency, datasets from individual sites and years were amalgamated into two datasets. The first dataset (the *biological dataset*) included all the information collected on individual amphibians which were captured during the RANA project; the second (the *trap night dataset*) included information on trapping effort and the number of animals captured by species. After amalgamation, datasets were checked for quality

and consistency. Records for animals which were caught incidentally (e.g. hand-captured, captured in traps which were accidentally left open) were removed. Records that appeared erroneous were checked against field sheets to determine accuracy. Where data were not recorded appropriately (e.g. weight recorded as 10+), or in cases where no data were recorded for a particular attribute (e.g. SVL), "not recorded" was entered for that parameter. Counts of animals captured based on the biological and trap night datasets were compared; where discrepancies existed, the original data were examined to determine the source of the discrepancy, and the data were adjusted to maintain consistency between the two datasets.

3.3 Estimating age class

Age classes were initially assigned to individual amphibians when they were captured in the field. These age classes were not consistent across sites or years, and included classes such as "adult", "juvenile", and "young-of-the-year". Because experience can influence the ability of an observer to assign animals to appropriate age classes, the age class of all individual amphibians was recoded *post hoc* using a set of rules based on date of capture and animal body length. This approach was based on the fact that amphibians in Alberta breed in the spring, and their young develop from eggs, through an aquatic larval stage, after which they emerge as metamorphs in mid-summer to fall. These young-of-the year (YOY) feed until they enter hibernation; in some cases, YOY do not grow much between metamorphosis and hibernation, so they may still be small (e.g. have a low SVL) when they emerge from hibernation in the spring. For this reason, any animals captured in the early part of the active season (e.g. May or June), were assigned to the "adult" age class, as they had survived one winter; note that these animals were not necessarily sexually mature, as it can take more than one year for the females of some species to reach reproductive maturity (Gibbons and McCarthy 1984; Hemelaar 1988). Metamorphosis periods for each species were obtained for Alberta populations from the Alberta Sustainable Resource Development (SRD) website (http://www.srd.alberta.ca/BioDiversityStewardship/WildSpecies/Amphibians/Default.aspx; accessed November 9, 2009) to delineate periods when only adults were likely to be present in the population (e.g. all animals, whatever the size, had survived one winter), and when YOY could be present (Table 3).

After assigning all individuals captured in the pre-metamorphosis period of the summer to the "adult" age class, SVL data for animals captured during the period when YOY were potentially emerging from natal pond were graphed. Histograms of SVL were constructed separately for each site and species; data were used for all years a particular site was sampled. Histograms were visually inspected for breaks in the data that would suggest discrete cohorts to estimate a maximum size for YOY for each species by site combination. This approach did not work well for all species, or where little data were available. For example, only one Canadian toad and 16 Columbia spotted frogs were captured; for these species there were not enough data to generate meaningful size histograms.

Long-toed salamanders were aged in the field based on both length and weight (Wilkinson, personal communication). A weight of 2 g was used as the cut-off between YOY and adults, which corresponded roughly with a maximum length of 4.0 cm. Sometimes longer, but skinny, YOY were found, as were short but fat adults, so it was necessary to use both length and weight criteria to differentiate YOY and adult individuals.

For individuals where no SVL data were recorded, age class was based on the designation assigned in the field. If an anuran (a frog or toad) was recorded as possessing a tail or tail bud, it was assigned to the YOY age class, unless the size of the animal or the notes related to it suggested it was an adult with a deformity. Adults that have retained their tails have been recorded in the wild on occasion (see the North American Reporting Center for Amphibian Malformations (NARCAM) -http://www.nbii.gov/portal/server.pt/community/amphibian_malformations/386).

3.4 Capture data

Amphibian captures were standardized by dividing the number of individuals captured in a trapping session by the number of trap nights for that session (1 trap open for 1 night = 1 trap night) and multiplying by 100 to get captures/100 trap nights. If a trap was compromised in some way (e.g. flooded, pulled out, etc.) it was recorded as a malfunction and it was not included in total trap nights.

4.0 DATA ANALYSIS

Linear and non-linear regression analyses were used to investigate trends over time (across years) of captures per 100 trap nights by age, site, species and session. These same procedures were used to investigate trends over time (across years) in mean SVL by age, site, species and session. Similarly, the relationship between spring adult captures and summer YOY captures in the same year were evaluated.

Spearman correlation coefficients were used to determine the strength of the relationship between YOY SVL and captures per 100 trap nights by site and species. Spearman correlation coefficients were also used to investigate the strength of the relationship between YOY captures in one year with adult captures in the spring and summer in the two years following, as the sample sizes were small and the data were non-normal. This analysis was done separately for each species and site.

Statistical significance was declared when $p \leq 0.05$. All statistical analyses were done using SAS Version 9.2 for Windows XP (SAS Institute Inc., Cary, NC).

Codes used to designate amphibian species in this document are given in Table 4.

5.0 RESULTS

5.1 Amphibian trapping

Pitfall traps were open a total of 2,583 nights over seven sites and 12 years of trapping. Trapping occurred most frequently in May and August overall, though the distribution of trapping effort varied across sites (Table 5).

A total of 67,299 trap nights were accumulated and 15,051 amphibians captured in pitfall traps during the RANA project to date. This equals an overall capture rate of 22.36 animals for every 100 trap nights. The number of animals captured varied widely within and between years at individual sites, as well as across sites. See Tables 6 and 7 for summaries of total captures, and captures per unit effort, respectively.

5.2 Estimating age classes

Data collected during trapping were used to estimate, *post hoc*, the maximum size (SVL) that YOY were likely to be at a given site for each species. An examination of the distribution of SVLs suggests that there is a breakpoint for some species which is likely related to the presence of a distinct YOY cohort. This breakpoint, or cut-off size, can then be used to classify individuals into adults or YOY based on field-collected data, hopefully providing objective criteria to avoid biases related to experience level and other factors when assigning animals to age classes. Estimated breakpoints by site and species are provided in Table 8. Histograms for individual species are provided in Figures 4 to 7. Age classes were assigned where size data were available, using these cut-offs unless otherwise noted.

5.3 Trends in population size

One of the main questions related to long-term monitoring efforts is whether there are changes in population size over time. It is notoriously difficult to predict changes in amphibian populations from year-to-year due to their irruptive nature, but here we examine the RANA project data to determine if there are long-term trends in abundance.

Most trends were negative, with decreased capture rates over the years a site was sampled, though few trends were significant. Both linear and quadratic relationships were evident; while linear relationships are intuitive, quadratic trends deserve some clarification. If the quadratic trend goes from high to low to high over time, this implies a population that appears to have decreased and then rebounded. On the other hand, if the quadratic trend goes from low to high to low again, this would be interpreted as a population spike followed by decreasing abundance. A

summary of all the significant and near-significant relationships is provided in Table 9; complete results are provided below for individual species at each site.

Jackpot years (years in which YOY production was markedly higher than average) occurred at least once at 6 of the 7 sites sampled; the wood frog was the species that exhibited jackpots most frequently (4 of the 8 jackpots were wood frogs) (Table 10). Jackpots did not appear to be synchronous in space (e.g. widely separated sites experienced jackpots in the same year). There were 3 wood frog jackpots in 2003, and northern leopard frog and long-toed salamander jackpots in 2006, at different sites, but these are the only suggestion of temporal synchrony between jackpot events (Table 10).

5.3.1 Cypress Hills (Figure 8)

There was a borderline significant decreasing linear trend in the number of adult BCFR captured per 100 trap nights from 1999 to 2006 based on spring data (R^2=0.58, p=0.078). There was a negative quadratic trend in the number of adult NLFR captured per 100 traps nights in the summer (R^2=0.88), suggesting that the abundance of adult leopard frogs had increased over time and then fallen again. However, this trend was not significant (p=0.1197). Spring captures of adult NLFR also decreased between 2000 and 2006, though in this case the trend was linear (R^2=0.97, p=0.0137). There was a borderline significant decreasing linear trend in the number of adult TISA captured per 100 trap nights from 1998 to 2006 based on summer data (R^2=0.47, p=0.087). There was no significant trend in the number of adult TISA captured per 100 trap nights from 1998 to 2006 based on the spring data (p=0.36). There was a jackpot YOY year in 2006 for NLFR.

5.3.2 Hinton (Figure 9)

There was a decreasing linear trend in adult BOTO captures per 100 trap nights during the summer season from 2000 to 2004 (R^2=0.38), however, this trend was not significant (p=0.2675). There was a borderline significant positive quadratic trend in adult BOTO captures per 100 trap nights from 2000 to 2006 based on the spring data (R^2=0.76, p=0.0564), with an initial decrease in relative abundance followed by an increase. There was a borderline significant negative linear trend in adult LTSA captures per 100 trap nights based on the spring sampling from 2000 to 2006 (R^2=0.62, p=0.0632). The minor negative quadratic trend seen in spring adult LTSA captures was not significant (R^2=0.23, p=0.59). There was a borderline significant negative quadratic trend in both spring and summer adult WOFR captures per 100 trap nights from 2000 to 2006 (R^2=0.73, p=0.0716 for spring; R^2=0.854, p=0.0558 for summer). These negative quadratic trends suggest increased relative abundance followed by subsequent decreased abundance. YOY jackpots occurred in 2006 for LTSA and in 2000 for WOFR.

5.3.3 Kananaskis1 (Figure 10)

From 1998 to 2000, there was a decreasing trend in summer adult BOTO captures per 100 trap nights, but this trend was not significant (p=0.2086). The positive quadratic trend from 1998 to 2001 in spring adult BOTO and LTSA captures per 100 trap nights was also non-significant (R^2=0.98, p=0.1330 for BOTO; R^2=0.98, p=0.1459 for LTSA). Regardless of whether a linear (R^2=0.48) or quadratic (R^2=0.89) line is fit to the spring adult WOFR capture data, the relationship between captures per 100 trap nights and year is not significant (p>0.30 for both). Note that data for Kananaskis1 were limited due to the number of years sampling was done.

5.3.4 Kananaskis2 (Figure 11)

There was a significant negative quadratic trend in summer adult BOTO captures per 100 trap nights from 2002 to 2008 (R^2=0.81, p=0.0372). The positive quadratic trend in spring adult BOTO captures per 100 trap nights from 2002 to 2006 was not significant (R^2=0.94, p=0.2452). There was no significant trend in the BOTO YOY, and trends in summer adult BOTO captures per 100 trap nights from 2002 to 2008 were also non-significant (R^2=0.02, p=0.7865). There was a borderline significant decreasing trend in captures per 100 trap nights for spring adult LTSA from 2002 to 2006 (R^2=0.71, p=0.0741), and a significant increasing linear trend in LTSA YOY captures per 100 trap nights from 2002 to 2008 (R^2=0.69, p=0.0204). The negative quadratic trend in summer adult WOFR captures per 100 trap nights from 2002 to 2008 was not significant (R^2=0.58, p=0.1776). There was no significant trend in spring adult WOFR captures per 100 trap nights from 2002 to 2006 (R^2=0.44, p=0.2247), or in WOFR YOYs (R^2=0.33, p=0.1774). There was a WOFR YOY jackpot in 2003.

5.3.5 Meanook (Figure 12):

There was a significant linear decreasing trend in captures per 100 trap nights for summer adult BCFR from 1997 to 2006 (R^2=0.64, p=0.0057). There was no significant trend in the BCFR YOY captures per 100 trap nights from 1998 to 2004 (R^2=0.32, p=0.3168). There was no significant trend in BOTO summer adult captures per 100 trap nights from 1997 to 2006 (R^2=0.30, p=0.2802). There was a BOTO YOY jackpot in 1998. There were no significant trends in either WOFR summer adult (R^2=0.42, p=0.1471) or WOFR YOY captures per 100 trap nights from 1997 to 2006.

5.3.6 Saskatoon Island (Figure 13)

There was no significant trend in spring or summer adult BCFR captures per 100 trap nights from 1999 to 2005 (R^2=0.03, p=0.7483 for spring; R^2=0.44, p=0.2190 for summer). There was no significant trend in summer adult BOTO captures per 100 trap nights from 2000 to 2005 (R^2=0.97, p=0.1109). The negative quadratic trend in summer adult WOFR captures per 100 trap nights from 1999 to 2005 was not significant (R^2=0.56, p=0.1960), and there was no

significant trend in spring adult WOFR captures per 100 trap nights from 1999 to 2005 (R^2=0.17, p=0.3626). There was a WOFR YOY jackpot in 2003.

5.3.7 Lesser Slave Lake (Figure 14)

There was no significant trend in summer adult BCFR captures per 100 trap nights from 1997 to 2004 (R^2=0.15, p=0.3483). Similarly, there was no significant trend in spring adult BCFR captures per 100 trap nights from 1998 to 2004 (R^2=0.46, p=0.1404). There was no significant trend in BCFR YOY captures per 100 trap nights. The positive quadratic trend in summer adult BOTO captures per 100 trap nights from 1998 to 2004 was borderline significant (R^2=0.69, p=0.0519), and there was a significant linear increase in spring adult BOTO captures per 100 trap nights (R^2=0.67, p=0.0456). There was a BOTO YOY jackpot in 2001. There was no significant trend in summer adult WOFR captures per 100 trap nights from 1997 to 2004 (R^2=0.39, p=0.2877), or in spring adult WOFR captures per 100 trap nights from 1998 to 2004 (R^2=0.27, p=0.2331). There was a WOFR YOY jackpot in 2003.

5.4 Correlations between adult and YOY abundance

An important question in monitoring is whether it is possible to use information gathered on abundance to predict the subsequent size of a portion of a population. For example, if we have information on the number of egg masses wood frogs have deposited at a site, can we predict the number of tadpoles or YOY that will result? Conversely, does the size of the YOY population in a year predict the size of the adult population over the next two years, when YOY from the present year might be expected to return as adults? This is based on the idea that a large percentage of YOY return to their pond of origin to breed. Here we explore (1) the relationship between the number of adult amphibians at a site in the spring with the number of YOY captured at the same site in the summer trapping period, and (2) the relationship between the number of YOY produced in a year with the number of adults captured at the same site 1 and 2 years later.

There was no real relationship between adult captures in the spring and YOY captures in the summer (Figures 15 – 18). The jackpot years, during which production of metamorphs is much higher than usual (e.g. wood frogs at Kananaskis2; Figure 17) stand out, but they are not correlated with high spring adult captures. The relationships are not clear; the only linear trend is for BCFR at Slave Lake, where summer YOY captures increase as spring adult captures increase, but this relationship was not statistically significant. For WOFR at the Slave Lake site, the highest spring adult capture rate was associated with the highest summer YOY capture rate for one year, but there were no similar instances in the dataset for other years or sites.

There were not enough data to examine the relationship between YOY in one year and the adult populations in the following two years for all species and site combinations. Even for those

combinations that are presented here, the number of sample points is relatively small and, in general, the relationships were not very strong. None of the relationships examined were significant (Figures 19a and b), suggesting that YOY abundance in any given year is not related to adult population size in the following two years.

5.5 Morphological data

Examining body size, indexed by SVL, can provide insight into the health of the members of a population. Mass can also be used as an index of health, especially when it is related to some index of body size, such as SVL. However, mass is more variable as it can be strongly influenced by the degree of hydration of the individual animals being weighed, which can be related to time of day, weather, moisture conditions in traps, etc. Therefore, although mass data were collected for most of the animals captured during the RANA project, these data have not been analyzed here. A summary of all the significant and near-significant relationships trends in mean SVL over time is provided in Table 11; complete results are provided below for individual species at each RANA site. A summary of the morphological data for each site is provided in Tables 12 – 18.

5.5.1 Cypress Hills (Figure 20)

There was no significant trend in SVL from 1999 to 2006 for the BCFR spring adults ($p=0.7218$). There was a linear decreasing trend in mean SVL for NLFR adults in the spring ($R^2=0.34$) from 2000 to 2006, however, this trend was not significant ($p=0.4203$). There was a borderline significant decreasing linear trend in the mean SVL of summer adult NLFR from 2000 to 2006 ($R^2=0.67$, $p=0.0917$). There was no significant trend in mean SVL for adult TISA from 1998 to 2006 based on spring ($p=0.9239$) or summer ($p=0.9585$) data.

5.5.2 Hinton (Figure 21)

There was a significant decreasing linear trend in mean SVL of adult BOTO during the summer session from 2000 to 2004 ($R^2=0.77$, $p=0.0493$); there was also a decreasing trend in the adult BOTO mean SVLs from 2000 to 2006 based on the spring data, but it was not significant ($R^2=0.23$, $p=0.2817$). There was no significant trend in adult LTSA mean SVL based on the spring sampling from 2000 to 2006 ($R^2=0.14$, $p=0.4137$). There was a borderline significant increasing trend in the summer adult LTSA mean SVLs from 2000 to 2006 ($R^2=0.58$, $p=0.0766$), and a borderline significant decreasing trend in the mean SVL for YOY LTSA during the same period ($R^2=0.57$, $p=0.0823$). There was no significant trend in spring or summer adult WOFR mean SVL from 2000 to 2006 ($p=0.9114$ for spring and $p=0.2680$ for summer), or in YOY SVL for the same period ($R^2=0.53$, $p=0.1011$).

5.5.3 Kananaskis1 (Figure 22)

There were no real trends in mean SVL for BOTO. There was no significant trend from 1998 to 2001 in the spring adult LTSA mean SVL (R^2=0.22, p=0.5351). From 1998 to 2001 there were no significant trends in adult WOFR mean SVL in the summer (R^2=0.97, p=0.1018) or spring (p=0.5804). Note that data for Kananaskis1 are limited due to the small number of years that sampling was done at this site.

5.5.4 Kananaskis2 (Figure 23)

There was no significant trend for adult BOTO mean SVL from 2002 to 2006 based on spring data (R^2=0.21, p= 0.5400), or from 2002 to 2008 based on summer data (R^2=0.31, p=0.1952). The decreasing linear trend in the mean SVL of spring adult LTSA from 2002 to 2005 was not significant (R^2=0.57, p=0.2419), and there was no significant trend in adult or YOY LTSA mean SVL from 2002 to 2008 (both p>0.50). There was no significant trend in spring or summer adult WOFR mean SVL from 2002 to 2006/2008 (both p>0.18), but a significant linear decreasing trend from 2002 to 2008 was found in YOY WOFR mean SVL (R^2=0.72, p=0.0155).

5.5.5 Meanook (Figure 24)

The increasing linear trend in mean SVL from 1997 to 2008 for summer adult BOTO is significant (R^2=0.53, p=0.0115). The remaining relationships show no significant trends (p>0.05).

5.5.6 Saskatoon Island (Figure 25)

The decreasing linear trend in mean SVL from 2000 to 2005 of BOTO adults in summer is borderline significant (R^2=0.99, p=0.0583). Summer adult WOFR also showed a significant decreasing trend between 1999 and 2005 (R^2=0.71, p=0.0178), while spring adults showed a borderline significant trend in the same years (R^2=0.49, p=0.0784). The remaining relationships show trends with no statistical significance (p>0.05).

5.5.7 Lesser Slave Lake (Figure 26)

The decreasing trend in mean SVL for WOFR summer adults is borderline significant (R^2=0.43, p=0.0779). The linear increasing trend in the mean SVL for BOTO YOY from 1997 to 2004 is significant (R^2=0.67, p=0.0126). None of the other relationships show statistically significant trends (p>0.05).

6.0 DISCUSSION

6.1 Introduction

Monitoring of amphibians over the past two decades has taken on an urgency related to declines in populations of these animals (Blaustein et al. 1994; Houlahan et al. 2000; Corser 2001; Carrier and Beebee 2003) and the need for long-term datasets to characterise natural population fluctuations in species that normally exhibit boom and bust cycles of recruitment (Blaustein et al. 1994; Storfer 2003). The mandate of the RANA project was to collect data on amphibian populations in several areas throughout Alberta to track changes in relative amphibian abundance over time, collect information on characteristics of individual amphibians in focal populations, and provide opportunities for public outreach on the topics of amphibian and wetland ecology.

The RANA project was able to collect data on a variety of amphibian species in a range of ecoregions within Alberta. However, because funding (and hence amount of survey effort) was intermittent, and because the project was partially reliant on volunteers, data collection (primarily in terms of trapping effort) was not consistent across sites and years. Field technicians often differed between sites and years as well, which may have biased data collection, though this was minimized in the RANA project through the use of standardized protocols, training, equipment, and data collection sheets. Even with these potential inconsistencies, data collected over the course of the project provide insights into changes in amphibian populations in Alberta, where long-term datasets on amphibians are largely lacking.

6.2 Trends in population size

Amphibian populations sampled during the RANA project experienced wide fluctuations in relative abundance, ranging from years when a species was not caught at a site at all to years when jackpots occurred and large numbers of YOY were produced. This pattern is common for amphibian populations; for example, virtually all 13 amphibian species inhabiting a wetland in South Carolina, USA, suffered total reproductive failure because of shortened hydroperiods in 4 of the 16 years (1978–1993) that the wetland was monitored (Semlitsch et al. 1996). In the first year following the end of a prolonged drought, a nearby wetland produced more than 360,000 YOY of 15 species (Gibbons et al. 2006). Populations of breeding adults also exhibit large variation in abundance across time (Berven 2009). Because many amphibians, especially those that breed in ponds (Green 2003) exhibit highly fluctuating populations, they are often prone to local extinction (Trenham et al. 2003). Species at a given site may go locally extinct independently of other species at the same site, with the rate of species turnover related to factors such as pond area, length of hydroperiod, canopy cover, and connectivity (Werner et al. 2007). These studies, and others like them, document the wide fluctuations naturally exhibited by amphibian populations.

6.3 Relationships between adult and YOY abundance

There is no real relationship between breeding effort at a site and the production of YOY in the same year, at least not as measured during the RANA project. There are several possible explanations for this. Species such as the wood frog and boreal chorus frog breed very early in the spring, and at least part of the breeding season may have been missed in terms of trapping at RANA sites because of the logistical difficulties inherent in hiring and/or training field personnel at the start of the field season. The disconnect between adult and YOY populations may also be explained by a variety of factors that impact egg or larval populations, such as premature drying of the aquatic habitat (Pechmann et al. 1989), aquatic predators (Brönmark and Edenhamn 1994; Wellborn et al. 1996; Heenar and M'Closkey 1997), and effects of density amongst amphibian larvae through competition and/or cannibalism (Petranka and Kennedy 1999).

Recruitment of YOY into a population may fluctuate widely, and often has little relationship with the relative abundance of adults returning to a site to breed in subsequent years. Data from the RANA project, though limited, suggest that there was no relationship between how many YOY were produced in one year and the number of breeding adults in the following two years. For some species, such as the wood frog, this disconnect may have been related to challenges in sampling breeding adults early in the spring. However, work elsewhere suggests that regulation of post-metamorphic populations occurs in the terrestrial environment and that density dependence effects limit the abundance of adult amphibians (Harper and Semlitsch 2007; Berven 2009). In addition, some individuals likely disperse to other sites.

6.4 Body size

Although there were a number of RANA project sites where the mean body size exhibited significant trends over time, there was no general pattern related to species or age class, though of 11 significant or near-significant trends, 8 were decreasing. Without having additional data on larval population size, drying rate of the different breeding ponds, and other potential explanatory variables, it is difficult to speculate as to the cause of such trends. In many cases relatively few individuals of a species and age class were captured, so the trends documented here may be artefacts.

Research has shown that body size of amphibians can be related to a number of factors. Size at metamorphosis has been related to habitat quality (lower habitat quality, in terms of food resources, results in smaller size at metamorphosis – Skelly and Werner 1990; Babbit 2001), degree of competition (smaller size with increased competition – Wilbur 1976; Crump 1981; Morin 1987), and presence and type of predator (reduced feeding activity in the presence of predators, resulting in lower size at metamorphosis – Skelly and Werner 1990; Wellborn et al. 1996; Babbit 2001), among other factors. The size of amphibians at metamorphosis can have

important implications for subsequent survival (Berven 1990; Morey and Reznick 2001; Altwegg and Reyer 2003), and body size as an adult (Smith 1987; Semlitsch et al. 1988; Berven 1990). Body size of adults may also be influenced by the density of, and therefore degree of competition among, adults in the terrestrial environment (Berven 2009). Smaller adult body size may mean fewer matings for males (Berven 1981), while egg production is positively related to body size in females (Howard 1980; Berven 1988, 2009; Howard and Kluge 1985).

Clearly, body size may provide some indication of habitat quality, but interpretation of what differences in body size mean over time may be difficult given the number of factors that influence this parameter. Measurement of body size at metamorphosis will reflect the quality of the aquatic natal habitat, including those factors outlined above. Size of adults, however, provides less information, as this parameter is influenced by size at metamorphosis (Berven 1990; Goater and Vandenbos 1997), differences in growth rates before maturity (Halliday and Verrell 1988; Ryser 1988), and the fact that growth in amphibians slows following sexual maturity (Ryser 1989; Smirina 1994; Kellner and Green 1995) so individuals of the same size may be of different age.

7.0 MANAGEMENT IMPLICATIONS

Populations of amphibians may persist at a site, even in the face of catastrophic larval mortality, as long as bust years do not occur too frequently (Griffiths 1997; Marsh and Trenham 2001; Richter et al. 2003). Adult amphibians may live for relatively long periods (e.g. Canadian toad in Alberta: 4–12 years (Eaton et al. 2005); wood frog in southern Quebec: 4–5 years (Bastien and LeClair 1992; Sagor et al. 1998); long-toed salamanders in Alberta: 10 years, with most individuals living a maximum of 6–7 years (Russell et al. 1996)). This, combined with the fact that males of many species start breeding as early as age 1, and females at age 2, means there is the potential for adults to breed for numerous years, though this potential is not always realized due to competition for mates (Berven 1981). Given the potential longevity of Alberta populations of amphibians, and the high fecundity of many of these species (e.g. the boreal toad produces 5,000 to 15,000 eggs per female (Blaustein et al. 1995)), populations may be able to survive short-term environmental perturbations (e.g. drying of breeding ponds) as long as adults are able to access suitable summer foraging and overwintering habitats. Although a population would only theoretically require successful breeding once in a generation, if the interval between recruitment of YOY into the population was too long, mortality of adults over time would result in an increasingly smaller breeding population with concomitant loss of genetic diversity and increased susceptibility to local extinction.

Amphibian populations are commonly envisioned as metapopulations – a collection of spatially separated populations of the same species that interact through immigration and emigration of individuals. In amphibians, most dispersers are juvenile (e.g. non-breeding) individuals, whereas adults exhibit high fidelity to their breeding sites; for example, at least 88% of adult wood frogs exhibit site fidelity (Berven and Grudzien 1990; Vasconcelos and Calhoun 2004). Adult amphibians will often return to breeding sites even after they have become unsuitable for breeding or larval survival (e.g. dry because of drought periods) (Matthews and Preisler 2010), though there is evidence that entire populations will shift between sites when fish are introduced into a breeding site (Petranka and Holbrook 2006). Populations experiencing local declines (e.g. long periods without successful breeding because of shortened hydroperiods) may be "rescued" by an influx of dispersers from other populations. Similarly, sites where populations go locally extinct may be recolonized by dispersers from nearby populations. The maximum dispersal distance for amphibians varies among species; Smith and Green (2005) found that anurans (frogs and toads) had a mean maximum dispersal distance of 2,923 m (based on 102 studies of 53 species), while the value for salamanders was 577 m (based on 64 studies of 37 species). These authors also determined that 56% of maximum movements by anurans were < 1 km, while this value was 94% for salamanders (Smith and Green 2005). Distance between ponds thus varies in its impact on the survival of populations of different species, and on the community of amphibians likely to colonize a pond, affecting potential conservation management of these habitats.

Although amphibian conservation in the past has largely centred on protection of breeding habitat, recent work on non-breeding habitats (e.g. summer foraging, overwintering) has suggested that the terrestrial environment plays a more important role in population regulation for a number of species (Harper and Semlitsch 2007; Berven 2009). Research has also indicated that landscape factors have an important influence on the persistence of amphibian populations in an area (Harper et al. 2008). Populations are more likely to survive in areas that support wetlands that run the range of the hydroperiod gradient (Snodgrass et al. 2000; Lehtinen and Galatowitsch 2001; Pechmann et al. 2001; Baldwin et al. 2006; Petranka and Holbrook 2006; Paton and Crouch 2002) and which occur at densities high enough to allow movement between sites (Semlitsch and Bodie 1998). In addition, suitable terrestrial habitat for foraging, overwintering, and dispersal must be available in the matrix in which breeding sites are embedded (Houlahan and Findlay 2003; Rothermel 2004; Baldwin et al. 2006; Cushman 2006; Harper et al. 2008). Suitable terrestrial habitat may differ among species, and even by sex or age class within the same species (Regosin et al. 2003; Bartlet et al. 2004; Rittenhouse and Semlitsch 2007). Regosin et al. (2005) found that males of three amphibian species, including the wood frog, tended to overwinter closer to the breeding site than females. In another study, Trenham and Shaffer (2005) found that the density of adult California tiger salamanders declined steadily

with distance from the breeding pond, while the density of subadults increased from 10 to 400 m from the breeding site, indicating differential use of upland habitat by these life history stages. Some researchers have suggested that the distribution of terrestrial habitats may play a larger role than the distribution of wetlands in influencing connectivity between amphibian populations (Marsh and Trenham 2001). For example, hibernation sites for Canadian toads (which are not freeze tolerant) may be limiting, and toads may move up to 1 km from ponds to reach these sites (Constible et al. 2010). The low dispersal ability of Canadian toads (Beiswenger 1986), the need for suitable overwintering sites (Kuyt 1991), and their extensive use of upland forested habitat (Constible et al. 2010) may make them vulnerable to changes in terrestrial habitats (Hamilton et al. 1998; Constible et al. 2010). Conservation efforts that focus only on breeding habitat are likely to fall short of their objectives in terms of maintaining amphibian populations in an area (Dodd and Cade 1998).

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TABLES

Table 1. Amphibian species that occur in Alberta, and their present provincial and federal designations. All but two of these species were captured at least once at RANA project sites; the two species never captured were the Great Plains Toad and the Spadefoot Toad.

Scientific name	Common name	Alberta status*	Alberta legal designation†	COSEWIC designation†
Ambystoma macrodactylum	Long-toed Salamander	Sensitive	Special concern	Not at risk
Ambystoma mavortium	Tiger Salamander	Secure	na	Not at risk
Anaxyrus boreas boreas	Western Toad	Sensitive	na	Special concern
Anaxyrus cognatus	Great Plains Toad	May be at risk	Data deficient	Special concern
Anaxyrus hemiophrys	Canadian Toad	May be at risk	Data deficient	Not at risk
Pseudacris maculata	Boreal Chorus Frog	Secure	na	na
Spea bombifrons	Plains Spadefoot Toad	May be at risk	na	Not at risk
Lithobates pipiens	Northern Leopard Frog	At risk	Threatened	Special concern
Lithobates sylvaticus	Wood Frog	Secure	na	na
Rana luteiventris	Columbia Spotted Frog	Sensitive	na	Not at risk

* Alberta Status of Wildlife Species, 2005 (Alberta Sustainable Resource Development 2005)
† na = not assessed

Table 2. Summary of sites and years trapped during the RANA project, 1997-2006; √ indicates a site was trapped in a given year.

Site	Year										Total # of yrs trapped*
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
Hinton				√	√	√	√	√	√	√	7
Kananaskis 1†		√	√	√	√						4
Kananaskis 2†						√	√	√	√	√	5
Lesser Slave Lake	√	√	√	√	√	√	√	√	√		9
Meanook	√	√	√	√	√	√	√	√	√	√	10
Saskatoon Is.			√	√	√	√	√	√	√		7
Cypress Hills		√	√	√			√	√	√	√	8
Total # of sites/yr	2	4	5	6	5	5	6	6	6	4	

* total number of years trapped per site up to 2006.

† Kananaskis1 dried in 2001 and was replaced with Kananaskis2, a nearby site.

Table 3. Periods when metamorphs of individual species could be present in a population (based on the Alberta Sustainable Resource Development (SRD) website (http://www.srd.alberta.ca/BioDiversityStewardship/WildSpecies/Amphibians/Default.aspx) accessed November 9, 2009).

Species	Transformation period (cut-off date*)
Boreal chorus frog	July – August (cut-off date: July 1)
Boreal toad	July – August (cut-off date: July 1)
Canadian toad	late June – September (cut-off date: June 23)
Columbia spotted frog	August – September (cut-off date: August 1)
Long-toed salamander	mid-August – September; using mid-August misses all the data from Kananaskis (site 1); therefore, adjusted the cut-off date to August 1
Northern leopard frog	last week of June – September (cut-off date: June 23)
Tiger salamander	early August – September (cut-off date: August 1)
Wood frog	mid June – September (cut-off date: June 15)

* all individuals captured before the cut-off date are considered adults, irrespective of size

Table 4. Amphibian common names and codes used in this document.

Common name	Code
wood frog	WOFR
northern leopard frog	NLFR
Columbia spotted frog	CSFR
boreal chorus frog	BCFR
boreal toad	BOTO
Canadian toad	CATO
long-toed salamander	LTSA
tiger salamander	TISA

Table 5. The number of nights that traps were open at RANA sites by site, month, and year.

Site	Month	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand Total
Cypress Hills														
	May	0	0	14	0	0	0	14	6	12	24	0	0	70
	June	0	0	24	23	0	0	25	30	30	25	0	0	157
	July	0	2	3	16	0	0	30	30	4	25	0	0	110
	August	0	12	2	20	0	0	30	28	28	31	0	0	151
	September	0	0	0	0	0	0	0	0	10	7	0	0	17
	Total	0	14	43	59	0	0	99	94	84	112	0	0	505
Hinton														
	May	0	0	0	11	28	18	21	22	11	15	0	0	126
	June	0	0	0	10	5	30	10	10	0	14	0	0	79
	July	0	0	0	0	0	0	0	0	0	0	0	0	0
	August	0	0	0	27	27	24	18	18	0	18	0	0	132
	September	0	0	0	0	7	30	11	19	0	14	0	0	81
	October	0	0	0	0	0	2	0	0	0	0	0	0	2
	Total	0	0	0	48	67	104	60	69	11	61	0	0	420
Kananaskis1														
	May	0	17	9	18	21	0	0	0	0	0	0	0	65
	June	0	13	19	10	2	0	0	0	0	0	0	0	44
	July	0	19	14	1	4	0	0	0	0	0	0	0	38
	August	0	11	5	0	0	0	0	0	0	0	0	0	16
	Total	0	60	47	29	27	0	0	0	0	0	0	0	163
Kananaskis2														
	May	0	0	0	0	0	11	30	18	0	21	0	0	80
	June	0	0	0	0	0	15	18	0	8	15	0	0	56
	July	0	0	0	0	0	0	0	0	0	0	0	0	0
	August	0	0	0	0	0	14	11	8	27	13	17	18	108
	September	0	0	0	0	0	2	8	8	31	0	14	6	69
	October	0	0	0	0	0	45	0	0	0	0	0	0	45
	Total	0	0	0	0	0	87	67	34	66	49	31	24	358

Table continues...

Table 5 continued. The number of nights that traps were open at RANA sites by site, month, and year.

Site	Month	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Grand Total
Meanook														
	May	0	0	0	1	0	0	0	0	0	23	0	0	24
	June	0	0	0	23	0	0	0	0	0	28	0	0	51
	July	11	16	7	30	12	12	28	24	26	33	0	0	199
	August	5	2	8	21	4	5	12	11	19	11	0	0	98
	Total	16	18	15	75	16	17	40	35	45	95	0	0	372
Saskatoon Island														
	April	0	0	0	0	0	0	2	0	0	0	0	0	2
	May	0	0	7	16	16	21	19	3	13	0	0	0	95
	June	0	0	22	11	9	6	0	18	22	0	0	0	88
	July	0	0	20	12	5	6	4	0	11	0	0	0	58
	August	0	0	7	16	23	19	17	22	30	0	0	0	134
	September	0	0	0	0	0	0	0	9	16	0	0	0	25
	Total	0	0	56	55	53	52	42	52	92	0	0	0	402
Slave Lake														
	May	0	0	14	11	0	20	14	15	3	0	0	0	77
	June	0	28	24	19	0	3	0	0	0	0	0	0	74
	July	11	20	27	22	0	0	0	0	0	0	0	0	80
	August	7	24	7	20	21	20	20	11	0	0	0	0	130
	September	0	0	0	0	0	0	0	2	0	0	0	0	2
	Total	18	72	72	72	21	43	34	28	3	0	0	0	363
Grand Total		34	164	233	338	184	303	342	312	301	317	31	24	2583

Table 6. Summary of the number of amphibians captured at RANA sites.

Site	Year	Session*	Total trap nights	Number of individuals captured								
				TISA	BOTO	BCFR	LTSA	NLFR	WOFR	CSFR	CATO	Total
Cypress Hills	1998	Summer	336	30	0	2	0	0	0	0	0	32
	1999	Spring	624	3	0	3	0	0	0	0	0	6
		Summer	408	9	0	1	0	0	0	0	0	10
	2000	Spring	216	6	0	2	0	5	0	0	0	13
		Summer	1200	9	0	0	0	13	0	0	0	22
	2003	Spring	580	0	0	1	0	0	0	0	0	1
		Summer	2045	10	0	0	0	71	0	0	0	81
	2004	Spring	411	1	0	1	0	6	0	0	0	8
		Summer	2226	56	0	0	0	54	0	0	0	110
	2005	Spring	576	1	0	1	0	8	0	0	0	10
		Summer	1301	14	0	0	0	89	0	0	0	103
	2006	Spring	1055	6	0	2	0	10	0	0	0	18
		Summer	2516	47	0	0	0	700	0	0	0	747
	Total		13494	192	0	13	0	956	0	0	0	1161
Hinton	2000	Spring	332	0	27	0	36	0	16	0	0	79
		Summer	424	0	17	0	95	0	329	0	0	441
	2001	Spring	528	0	7	0	102	0	34	0	0	143
		Summer	544	0	10	0	58	0	35	0	0	103
	2002	Spring	512	0	17	0	113	0	46	0	0	176
		Summer	1152	0	12	0	105	0	127	0	0	244
	2003	Spring	496	0	1	0	73	0	26	0	0	100
		Summer	450	0	9	0	14	0	28	0	0	51
	2004	Spring	502	0	3	0	104	0	27	0	0	134
		Summer	592	0	9	0	19	0	36	0	0	64
	2005	Spring	176	0	2	0	11	0	5	0	0	18
	2006	Spring	463	0	12	0	71	0	10	0	0	93
		Summer	512	0	0	0	549	0	12	0	0	561
	Total		6683	0	126	0	1350	0	731	0	0	2207

Table continues...

Table 6 continued. Summary of the number of amphibians captured at RANA sites.

Site	Year	Session*	Total trap nights	Number of individuals captured								
				TISA	BOTO	BCFR	LTSA	NLFR	WOFR	CSFR	CATO	Total
Kananaskis1	1998	Spring	420	0	23	0	34	0	15	4	0	76
		Summer	648	0	11	0	153	0	45	3	0	212
	1999	Spring	377	0	2	0	10	0	8	2	0	22
		Summer	461	0	9	0	0	0	4	0	0	13
	2000	Spring	409	0	2	0	6	0	2	0	0	10
		Summer	108	0	1	0	0	0	1	0	0	2
	2001	Spring	378	0	11	0	33	0	8	1	0	53
		Summer	106	0	0	0	2	0	2	0	0	4
	Total		2907	0	59	0	238	0	85	10	0	392
Kananaskis2	2002	Spring	400	0	4	0	96	0	5	0	0	105
		Summer	992	0	34	0	350	0	207	3	0	594
	2003	Spring	720	0	7	0	126	0	16	0	0	149
		Summer	352	0	20	0	147	0	202	1	0	370
	2004	Spring	288	0	0	0	55	0	11	0	0	66
		Summer	256	0	13	0	163	0	14	0	0	190
	2005	Spring	126	0	2	0	1	0	1	0	0	4
		Summer	792	0	45	0	384	0	31	1	0	461
	2006	Spring	560	0	25	0	41	0	48	0	0	114
		Summer	224	0	11	0	127	0	51	0	0	189
	2007	Summer	450	0	8	0	375	0	14	1	0	398
	2008	Summer	336	0	7	0	245	0	3	0	0	255
	Total		5496	0	176	0	2110	0	603	6	0	2895

Table continues...

Table 6 continued. Summary of the number of amphibians captured at RANA sites.

Site	Year	Session*	Total trap nights	Number of individuals captured								
				TISA	BOTO	BCFR	LTSA	NLFR	WOFR	CSFR	CATO	Total
Meanook	1997	Summer	518	0	2	4	0	0	160	0	0	166
	1998	Summer	754	0	343	4	0	0	277	0	0	624
	1999	Summer	630	0	7	2	0	0	23	0	0	32
	2000	Spring	504	0	6	7	0	0	14	0	0	27
		Summer	2646	0	134	9	0	0	39	0	0	182
	2001	Summer	640	0	8	3	0	0	316	0	0	327
	2002	Summer	714	0	12	1	0	0	65	0	0	78
	2003	Summer	1561	0	23	16	0	0	982	0	0	1021
	2004	Summer	1400	0	3	5	0	0	293	0	0	301
	2005	Summer	1844	0	10	3	0	0	446	0	0	459
	2006	Spring	1554	0	32	1	0	0	71	0	0	104
		Summer	2436	0	18	1	0	0	472	0	0	491
	Total		15201	0	598	56	0	0	3158	0	0	3812
Saskatoon Island	1999	Spring	419	0	0	2	0	0	58	0	0	60
		Summer	689	0	0	4	0	0	50	0	0	54
	2000	Spring	459	0	0	10	0	0	17	0	0	27
		Summer	621	0	2	7	0	0	26	0	0	35
	2001	Spring	438	0	0	1	0	0	16	0	0	17
		Summer	617	0	3	4	0	0	47	0	0	54
	2002	Spring	425	0	0	2	0	0	52	0	0	54
		Summer	558	0	0	2	0	0	113	0	0	115
	2003	Spring	408	0	0	8	0	0	21	0	0	29
		Summer	420	0	0	0	0	0	149	0	0	149
	2004	Spring	320	0	0	0	0	0	28	0	0	28
		Summer	672	0	0	0	0	0	21	0	0	21
	2005	Spring	527	0	0	1	0	0	7	0	0	8
		Summer	1287	0	10	2	0	0	14	0	0	26
	Total		7860	0	15	43	0	0	619	0	0	677

Table continues...

Table 6 continued. Summary of the number of amphibians captured at RANA sites.

Site	Year	Session*	Total trap nights	Number of individuals captured								
				TISA	BOTO	BCFR	LTSA	NLFR	WOFR	CSFR	CATO	Total
Lesser Slave Lake	1997	Summer	488	0	5	7	0	0	67	0	0	79
	1998	Spring	1200	0	7	2	0	0	9	0	1	19
		Summer	2236	0	16	1	0	0	23	0	0	40
	1999	Spring	1104	0	23	16	0	0	68	0	0	107
		Summer	2208	0	91	41	0	0	52	0	0	184
	2000	Spring	1008	0	13	17	0	0	15	0	0	45
		Summer	2448	0	69	9	0	0	28	0	0	106
	2001	Summer	840	0	819	28	0	0	83	0	0	930
	2002	Spring	898	0	20	282	0	0	119	0	0	421
		Summer	790	0	133	17	0	0	76	0	0	226
	2003	Spring	560	0	27	38	0	0	224	0	0	289
		Summer	800	0	51	18	0	0	789	0	0	858
	2004	Spring	600	0	67	126	0	0	212	0	0	405
		Summer	358	0	184	1	0	0	10	0	0	195
	2005	Spring	120	0	0	0	0	0	3	0	0	3
	Total		15658	0	1525	603	0	0	1778	0	1	3907
Grand Total			**67299**	**192**	**2499**	**715**	**3698**	**956**	**6974**	**16**	**1**	**15051**

* Note that the Spring session includes all captures up to June 14th, while the Summer session includes all captures from June 15 and on; † See Table 4 for species codes.

Table 7. Summary of the number of amphibians captured per 100 traps nights at RANA sites.

Site	Year	Session	Total trap nights	Number of individuals captured								
				TISA	BOTO	BCFR	LTSA	NLFR	WOFR	CSFR	CATO	Total
Cypress Hills	1998	Summer	336	8.93	0	0.60	0	0	0	0	0	9.52
	1999	Spring	624	0.48	0	0.48	0	0	0	0	0	0.96
		Summer	408	2.21	0	0.25	0	0	0	0	0	2.45
	2000	Spring	216	2.78	0	0.93	0	2.31	0	0	0	6.02
		Summer	1200	0.75	0	0	0	1.08	0	0	0	1.83
	2003	Spring	580	0	0	0.17	0	0	0	0	0	0.17
		Summer	2045	0.49	0	0	0	3.47	0	0	0	3.96
	2004	Spring	411	0.24	0	0.24	0	1.46	0	0	0	1.95
		Summer	2226	2.52	0	0	0	2.43	0	0	0	4.94
	2005	Spring	576	0.17	0	0.17	0	1.39	0	0	0	1.74
		Summer	1301	1.08	0	0	0	6.84	0	0	0	7.92
	2006	Spring	1055	0.57	0	0.19	0	0.95	0	0	0	1.71
		Summer	2516	1.87	0	0	0	27.82	0	0	0	29.69
	Total		13494	1.42	0	0.10	0	7.08	0	0	0	8.60
Hinton	2000	Spring	332	0	8.13	0	10.84	0	4.82	0	0	23.80
		Summer	424	0	4.01	0	22.41	0	77.59	0	0	104.01
	2001	Spring	528	0	1.33	0	19.32	0	6.44	0	0	27.08
		Summer	544	0	1.84	0	10.66	0	6.43	0	0	18.93
	2002	Spring	512	0	3.32	0	22.07	0	8.98	0	0	34.38
		Summer	1152	0	1.04	0	9.11	0	11.02	0	0	21.18
	2003	Spring	496	0	0.20	0	14.72	0	5.24	0	0	20.16
		Summer	450	0	2.00	0	3.11	0	6.22	0	0	11.33
	2004	Spring	502	0	0.60	0	20.72	0	5.38	0	0	26.69
		Summer	592	0	1.52	0	3.21	0	6.08	0	0	10.81
	2005	Spring	176	0	1.14	0	6.25	0	2.84	0	0	10.23
	2006	Spring	463	0	2.59	0	15.33	0	2.16	0	0	20.09
		Summer	512	0	0	0	107.23	0	2.34	0	0	109.57
	Total		6683	0	1.89	0	20.20	0	10.94	0	0	33.02

Table continues...

Table 7 continued. Summary of the number of amphibians captured per 100 traps nights at RANA sites.

Site	Year	Session	Total trap nights	Number of individuals captured								
				TISA	BOTO	BCFR	LTSA	NLFR	WOFR	CSFR	CATO	Total
Kananaskis1	1998	Spring	420	0	5.48	0	8.10	0	3.57	0.95	0	18.10
		Summer	648	0	1.70	0	23.61	0	6.94	0.46	0	32.72
	1999	Spring	377	0	0.53	0	2.65	0	2.12	0.53	0	5.84
		Summer	461	0	1.95	0	0	0	0.87	0	0	2.82
	2000	Spring	409	0	0.49	0	1.47	0	0.49	0	0	2.44
		Summer	108	0	0.93	0	0	0	0.93	0	0	1.85
	2001	Spring	378	0	2.91	0	8.73	0	2.12	0.26	0	14.02
		Summer	106	0	0	0	1.89	0	1.89	0	0	3.77
	Total		2907	0	2.03	0	8.19	0	2.92	0.34	0	13.48
Kananaskis2	2002	Spring	400	0	1.00	0	24.00	0	1.25	0	0	26.25
		Summer	992	0	3.43	0	35.28	0	20.87	0.30	0	59.88
	2003	Spring	720	0	0.97	0	17.50	0	2.22	0	0	20.69
		Summer	352	0	5.68	0	41.76	0	57.39	0.28	0	105.11
	2004	Spring	288	0	0	0	19.10	0	3.82	0	0	22.92
		Summer	256	0	5.08	0	63.67	0	5.47	0	0	74.22
	2005	Spring	126	0	1.59	0	0.79	0	0.79	0	0	3.17
		Summer	792	0	5.68	0	48.48	0	3.91	0.13	0	58.21
	2006	Spring	560	0	4.46	0	7.32	0	8.57	0	0	20.36
		Summer	224	0	4.91	0	56.70	0	22.77	0	0	84.38
	2007	Summer	450	0	1.78	0	83.33	0	3.11	0.22	0	88.44
	2008	Summer	336	0	2.08	0	72.92	0	0.89	0	0	75.89
	Total		5496	0	3.20	0	38.39	0	10.97	0.11	0	52.67

Table continues...

Table 7 continued. Summary of the number of amphibians captured per 100 traps nights at RANA sites.

Site	Year	Session	Total trap nights	Number of individuals captured								
				TISA	BOTO	BCFR	LTSA	NLFR	WOFR	CSFR	CATO	Total
Meanook	1997	Summer	518	0	0.39	0.77	0	0	30.89	0	0	32.05
	1998	Summer	754	0	45.49	0.53	0	0	36.74	0	0	82.76
	1999	Summer	630	0	1.11	0.32	0	0	3.65	0	0	5.08
	2000	Spring	504	0	1.19	1.39	0	0	2.78	0	0	5.36
		Summer	2646	0	5.06	0.34	0	0	1.47	0	0	6.88
	2001	Summer	640	0	1.25	0.47	0	0	49.38	0	0	51.09
	2002	Summer	714	0	1.68	0.14	0	0	9.10	0	0	10.92
	2003	Summer	1561	0	1.47	1.02	0	0	62.91	0	0	65.41
	2004	Summer	1400	0	0.21	0.36	0	0	20.93	0	0	21.50
	2005	Summer	1844	0	0.54	0.16	0	0	24.19	0	0	24.89
	2006	Spring	1554	0	2.06	0.06	0	0	4.57	0	0	6.69
		Summer	2436	0	0.74	0.04	0	0	19.38	0	0	20.16
	Total		15201	0	3.93	0.37	0	0	20.77	0	0	25.08
Saskatoon Island	1999	Spring	419	0	0	0.48	0	0	13.84	0	0	14.32
		Summer	689	0	0	0.58	0	0	7.26	0	0	7.84
	2000	Spring	459	0	0	2.18	0	0	3.70	0	0	5.88
		Summer	621	0	0.32	1.13	0	0	4.19	0	0	5.64
	2001	Spring	438	0	0	0.23	0	0	3.65	0	0	3.88
		Summer	617	0	0.49	0.65	0	0	7.62	0	0	8.75
	2002	Spring	425	0	0	0.47	0	0	12.24	0	0	12.71
		Summer	558	0	0	0.36	0	0	20.25	0	0	20.61
	2003	Spring	408	0	0	1.96	0	0	5.15	0	0	7.11
		Summer	420	0	0	0	0	0	35.48	0	0	35.48
	2004	Spring	320	0	0	0	0	0	8.75	0	0	8.75
		Summer	672	0	0	0	0	0	3.13	0	0	3.13
	2005	Spring	527	0	0	0.19	0	0	1.33	0	0	1.52
		Summer	1287	0	0.78	0.16	0	0	1.09	0	0	2.02
	Total		7860	0	0.19	0.55	0	0	7.88	0	0	8.61

Table continues...

Table 7 continued. Summary of the number of amphibians captured per 100 traps nights at RANA sites.

Site	Year	Session	Total trap nights	Number of individuals captured								
				TISA	BOTO	BCFR	LTSA	NLFR	WOFR	CSFR	CATO	Total
Lesser Slave Lake	1997	Summer	488	0	1.02	1.43	0	0	13.73	0	0	16.19
	1998	Spring	1200	0	0.58	0.17	0	0	0.75	0	0.08	1.58
		Summer	2236	0	0.72	0.04	0	0	1.03	0	0	1.79
	1999	Spring	1104	0	2.08	1.45	0	0	6.16	0	0	9.69
		Summer	2208	0	4.12	1.86	0	0	2.36	0	0	8.33
	2000	Spring	1008	0	1.29	1.69	0	0	1.49	0	0	4.46
		Summer	2448	0	2.82	0.37	0	0	1.14	0	0	4.33
	2001	Summer	840	0	97.50	3.33	0	0	9.88	0	0	110.71
	2002	Spring	898	0	2.23	31.40	0	0	13.25	0	0	46.88
		Summer	790	0	16.84	2.15	0	0	9.62	0	0	28.61
	2003	Spring	560	0	4.82	6.79	0	0	40	0	0	51.61
		Summer	800	0	6.38	2.25	0	0	98.63	0	0	107.25
	2004	Spring	600	0	11.17	21.00	0	0	35.33	0	0	67.50
		Summer	358	0	51.40	0.28	0	0	2.79	0	0	54.47
	2005	Spring	120	0	0	0	0	0	2.50	0	0	2.50
	Total		15658	0	9.74	3.85	0	0	11.36	0	0.01	24.95
Grand Total			**67299**	0.29	3.71	1.06	5.49	1.42	10.36	0.02	0.0015	22.36

Table 8. Maximum sizes of YOY by species, based on visual estimation of break-points in the distribution of SVL data for each RANA site. Note that, for some species, the maximum SVL of YOY differs between sites.

Species*	Site	Estimated maximum SVL for YOY (cm)	Notes
Boreal chorus frog	Meanook	1.8	Few data, pattern tenuous
	Saskatoon Island	1.8	Few data, pattern tenuous
	Lesser Slave Lake	1.9	
Boreal toad	Hinton	3.0	Few data
	Kananaskis1	3.2	Few data
	Kananaskis2	3.2	Few data
	Meanook	2.1	Size of YOY quite different for this site
	Saskatoon Island	3	Few data
	Lesser Slave Lake	3	
Long-toed salamander	Hinton	4.0	Length criterion was coupled with a weight limit of 2 g for YOY to assign age class
	Kananaskis1	4.0	
	Kananaskis2	4.0	
Northern leopard frog	Cypress Hills	3.9	Not a strong pattern
Tiger salamander	Cypress Hills	?	No discernible pattern
Wood frog	Hinton	2.6	
	Kananaskis1	2.7	
	Kananaskis2	2.2	
	Meanook	2.8	
	Saskatoon Island	2.9	
	Lesser Slave Lake	3.4	

* Canadian toad is not included here, as only one individual of this species was captured during the RANA project; Columbia spotted frog is not included here as only 16 individuals of this species were captured.

Table 9. Summary of significant (P-value<0.05) and near-significant (P-value<0.10) trends in amphibian relative abundance at RANA project sites over time. Significant trends are in bold type.

Site	Species (no. non-sign.)*	Season†	Age class	Type	Overall trend	R^2	P-value
Cypress Hills	BCFR (0)	Spr	Adult	Linear	Decreasing	0.58	0.078
	NLFR (2)	**Sum**	**Adult**	**Linear**	**Decreasing**	**0.97**	**0.014**
	TISA (2)	Sum	Adult	Linear	Decreasing	0.47	0.087
Hinton	BOTO (1)	Spr	Adult	Quadratic	Increasing	0.76	0.056
	LTSA (2)	Spr	Adult	Linear	Decreasing	0.62	0.063
	WOFR(1)	Sum	Adult	Quadratic	Decreasing	0.854	0.056
	WOFR	Spr	Adult	Quadratic	Decreasing	0.73	0.072
Kananaskis1	BOTO (2)						
	LTSA (1)			No significant relationships			
	WOFR (2)						
Kananaskis2	**BOTO (2)**	**Sum**	**Adult**	**Quadratic**	**Decreasing**	**0.81**	**0.037**
	LTSA (1)	Spr	Adult	Linear	Decreasing	0.71	0.074
	LTSA	**Sum**	**YOY**	**Linear**	**Increasing**	**0.69**	**0.020**
	WOFR (3)			No significant relationships			
Meanook	**BCFR (1)**	**Sum**	**Adult**	**Linear**	**Decreasing**	**0.64**	**0.0057**
	WOFR (2)			No significant relationships			
	BOTO (2)			No significant relationships			
Saskatoon Island	BOTO (2)						
	LTSA (1)			No significant relationships			
	WOFR (2)						
Lesser Slave Lake	BOTO (1)	Sum	Adult	Quadratic	Increasing	0.69	0.052
	BOTO	**Spr**	**Adult**	**Linear**	**Increasing**	**0.67**	**0.046**
	BCFR (3)			No significant relationships			
	WOFR (3)			No significant relationships			

* See Table 4 for species codes; the number in brackets following the species code is the number of non-significant trends for each species at a particular site. For example, trends in relative abundance over time for NLFR at Cypress Hills were not significant for either Spring adults or Summer YOY.

† Note that the Spring (Spr) session includes all captures up to June 14th, while the Summer (Sum) session includes all captures from June 15 and on.

Table 10. Summary of jackpot years (years in which unusually high production of YOY occurred).

Site	Yr of jackpot	Species*	No. yrs trapped	Yrs trapped
Cypress Hills	2006	NLFR	7	1998–2000, 2003–2006
Hinton	2000	WOFR	7	2000–2006
	2006	LTSA		
Kananaskis1	none	–	4	1998–2001
Kananaskis2	2003	WOFR	7	2002–2008
Meanook	1998	BOTO	10	1997–2006
Saskatoon Island	2003	WOFR	7	1999–2005
Lesser Slave Lake	2001	BOTO	9	1997–2005
	2003	WOFR		

* See Table 4 for species codes.

Table 11. Summary of significant (P-value<0.05) and near-significant (P-value<0.10) trends in mean SVL for amphibian species at RANA project sites over time. Significant trends are in bold type.

Site	Species (no. non-sign.)*	Season†	Age class	Type	Overall trend	R^2	P-value
Cypress Hills	BCFR (1)			No significant relationships			
	NLFR (2)	Sum	Adult	Linear	Decreasing	0.67	0.092
	TISA (3)			No significant relationships			
Hinton	**BOTO (1)**	**Sum**	**Adult**	**Linear**	**Decreasing**	**0.77**	**0.049**
	LTSA (1)	Sum	Adult	Linear	Increasing	0.58	0.077
	LTSA	Sum	YOY	Linear	Decreasing	0.57	0.082
	WOFR(3)			No significant relationships			
Kananaskis1	BOTO (2)			No significant relationships			
	LTSA (1)						
	WOFR (2)						
Kananaskis2	BOTO (3)			No significant relationships			
	LTSA (3)			No significant relationships			
	WOFR (2)	**Sum**	**YOY**	**Linear**	**Decreasing**	**0.72**	**0.016**
Meanook	BCFR (2)			No significant relationships			
	BOTO (1)	**Sum**	**Adult**	**Linear**	**Increasing**	**0.53**	**0.012**
	WOFR (2)			No significant relationships			
Saskatoon Island	BCFR (3)			No significant relationships			
	BOTO (0)	Sum	Adult	Linear	Decreasing	0.99	0.058
	WOFR (1)	Spr	Adult	Linear	Decreasing	0.49	0.078
	WOFR	**Sum**	**Adult**	**Linear**	**Decreasing**	**0.71**	**0.018**
Lesser Slave Lake	BCFR (3)			No significant relationships			
	BOTO (2)	**Sum**	**YOY**	**Linear**	**Increasing**	**0.67**	**0.013**
	WOFR (2)	Sum	Adult	Linear	Decreasing	0.43	0.078

* See Table 4 for species codes; the number in brackets following the species code is the number of non-significant trends for each species at a particular site. For example, trends in relative abundance over time for NLFR at Cypress Hills were not significant for either Spring adults or Summer YOY.

† Note that the Spring (Spr) session includes all captures up to June 14th, while the Summer (Sum) session includes all captures from June 15 and on.

Table 12. Summary of morphological data for the Cypress Hills RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
1998	Summer	BCFR	YOY	2.00	1.8-2.2	2	0.45	0.4-0.5	2
		TISA	Adult	9.59	7.5-12	29	29.59	11-51	29
			YOY	8.30	na	1	16.00	na	1
1999	Spring	BCFR	Adult	2.33	2-2.5	3	3.33	3-3.5	3
		TISA	Adult	7.83	7-9	3	19.00	18-20	3
	Summer	BCFR	Adult	2.50	na	1	4.00	na	1
		TISA	Adult	8.94	7-11	9	31.33	18-40	9
2000	Spring	BCFR	Adult	2.75	2.7-2.8	2	3.75	3.5-4	2
		NLFR	Adult	6.28	4.5-10.4	5	26.40	8-73	5
		TISA	Adult	8.88	7.7-10.3	6	33.08	20-46.5	6
	Summer	NLFR	Adult	5.79	4.7-9	13	17.38	6.5-49	13
		TISA	Adult	8.59	7.4-9.6	9	23.28	16-36	9
2003	Spring	BCFR	Adult	2.10	na	1	0.61	na	1
	Summer	NLFR	Adult	4.27	4-5.5	69	5.90	4.6-7	69
			YOY	3.40	na	1	3.00	na	1
		TISA	Adult	9.45	8.1-10.6	10	28.81	20.5-37.5	10
2004	Spring	BCFR	Adult	2.60	na	1	0.50	na	1
		NLFR	Adult	5.90	4.8-9.5	6	19.65	0.8-64	6
		TISA	Adult	6.00	na	1	10.00	na	1
	Summer	NLFR	Adult	4.79	4-6.3	53	9.91	5-25	52
		TISA	Adult	10.06	8.5-11.5	10	36.38	15-55	10
			YOY	7.73	6.5-9	45	18.02	11-31	45
2005	Spring	BCFR	Adult	3.00	na	1	1.00	na	1
		NLFR	Adult	6.37	4.6-7.4	6	23.50	9-31	6
		TISA	Adult	9.50	na	1	20.00	na	1
	Summer	NLFR	Adult	4.58	4-6.6	33	11.15	6.4-31	33
			YOY	3.55	2.9-3.9	51	7.66	4.9-11	52
		TISA	Adult	8.78	7.9-9.9	11	32.23	21-51	11
			YOY	6.97	6.4-7.6	3	17.33	14-20	3
2006	Spring	BCFR	Adult	1.80	1-2.6	2	1.95	1-2.9	2
		NLFR	Adult	5.09	2.6-54	10	25.50	4-49	9
		TISA	Adult	8.61	8-9.4	4	31.00	24-35	3
	Summer	NLFR	Adult	4.38	3.91-6.54	35	9.69	5.9-32	34
			YOY	3.36	2.66-4.2	640	6.87	4.2-10	646
		TISA	Adult	8.85	7.97-10.07	12	35.13	20.5-49	12
			YOY	7.45	6.3-9.46	35	18.99	11-27.5	35
Totals		BCFR	Adult	2.39	1-3	11	2.50	0.5-4	11
			YOY	2.00	1.8-2.2	2	0.45	0.4-0.5	2
		NLFR	Adult	4.71	2-10.4	230	10.87	0.8-73	227
			YOY	3.38	2.66-4.2	692	6.92	3-11	699
		TISA	Adult	9.15	6-12	105	30.35	10-55	104
			YOY	7.59	6.3-9.46	84	18.38	11-31	84

* Note that the Spring session includes all captures up to June 14th, while the Summer session includes all captures from June 15 and on; † See Table 4 for species codes.

Table 13. Summary of morphological data for the Hinton RANA site.

Year	Session[a]	Species[†]	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
2000	Spring	BOTO	Adult	7.65	6.1-9.6	25	47.00	27-94	25
		LTSA	Adult	6.76	5.4-8.5	36	5.72	3-10	36
		WOFR	Adult	4.74	3.9-5.7	16	10.23	7-15	16
	Summer	BOTO	Adult	7.31	5.6-8.7	13	45.87	4.3-73	13
			YOY	2.98	2.9-3	4	3.88	2.5-4.5	4
		LTSA	Adult	4.53	3.7-6.7	62	2.90	2-8	62
			YOY	4.05	3.6-4.6	33	1.42	1-2	33
		WOFR	Adult	4.53	3.9-5.2	12	11.17	5-18	12
			YOY	2.06	1.7-2.5	318	0.42	0.2-0.7	318
2001	Spring	BOTO	Adult	9.83	8-11.5	7	71.61	38-83	7
		LTSA	Adult	5.95	5.1-7	101	5.89	3.5-8.5	101
		WOFR	Adult	4.64	3.8-5.8	33	10.35	7-17.5	33
	Summer	BOTO	Adult	6.55	5-8.2	10	35.33	12-88	9
		LTSA	Adult	3.67	1.5-5.8	48	3.46	2-6.5	48
			YOY	3.72	3.3-5	10	1.59	1.3-2	10
		WOFR	Adult	4.47	2.9-5.5	23	12.05	1.5-21	22
			YOY	2.37	2.2-2.5	9	1.94	1-3	9
2002	Spring	BOTO	Adult	7.32	6.4-8.7	17	46.11	26-75	16
		LTSA	Adult	6.55	5-8.1	113	5.35	2.6-9.5	113
		WOFR	Adult	4.37	2.4-5.1	46	9.43	1.5-15	46
	Summer	BOTO	Adult	7.04	5.3-8.9	12	37.75	12-83	12
		LTSA	Adult	5.58	3.4-7.7	17	4.31	2-10.4	17
			YOY	3.53	2.8-4.9	88	1.11	0.5-1.8	88
		WOFR	Adult	4.39	2.8-5.5	67	9.29	1.5-16.4	67
			YOY	2.31	2.1-2.6	60	1.33	1-1.6	60
2003	Spring	BOTO	Adult	8.30	na	1	63.00	na	1
		LTSA	Adult	6.36	5-7.3	72	4.64	3-7.5	72
		WOFR	Adult	4.18	1.2-5	26	7.85	1-11.6	26
	Summer	BOTO	Adult	6.09	4-8.2	9	25.97	7.5-65	9
		LTSA	Adult	5.54	4-7.5	10	4.41	2-8.4	9
			YOY	3.90	3.7-4	4	1.50	1.2-1.8	4
		WOFR	Adult	4.66	4.2-5.5	21	13.76	9-18.2	21
			YOY	2.29	1.5-2.6	7	1.71	1.4-2	7
2004	Spring	BOTO	Adult	3.33	3.1-3.5	3	3.57	3.4-3.8	3
		LTSA	Adult	5.80	4-6.8	102	4.68	3.1-7.8	104
		WOFR	Adult	4.39	2-5.9	26	8.32	1-15.9	27
	Summer	BOTO	Adult	4.91	3.5-7.6	9	15.53	1.9-47	9
		LTSA	Adult	5.40	4.4-7.1	15	3.89	2.3-7.5	15
			YOY	3.68	3.4-3.9	4	1.53	1.3-1.7	4
		WOFR	Adult	4.63	3.2-5.4	23	11.47	3.9-18.1	23
			YOY	2.26	1.4-2.6	13	1.49	1.2-2.1	13
2005	Spring	BOTO	Adult	7.50	7.5-7.5	2	48.20	36.4-60	2
		LTSA	Adult	6.13	5.5-7	11	5.74	5-8.5	11
		WOFR	Adult	4.18	3.7-4.6	5	7.52	4-13.4	5

Table continues...

Table 13 continued. Summary of morphological data for the Hinton RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
2006	Spring	BOTO	Adult	6.43	4.2-9	12	26.93	6-73.6	12
		LTSA	Adult	6.36	5.5-7.1	70	5.63	3.1-10.1	68
		WOFR	Adult	5.12	4.3-5.9	10	11.43	8.8-14.9	7
	Summer	LTSA	Adult	5.99	4.5-7	7	4.96	3.1-8.1	7
			YOY	3.27	2.7-4.5	540	0.91	0.5-2	541
		WOFR	Adult	3.98	2.7-8.5	10	3.92	1.8-10.2	10
			YOY	2.50	2.5-2.5	2	2.00	2-2	2
Totals		BOTO	Adult	6.99	3.1-11.5	120	39.39	1.9-94	118
			YOY	2.98	2.9-3	4	3.88	2.5-4.5	4
		LTSA	Adult	5.84	1.5-8.5	664	4.86	2-10.4	663
			YOY	3.36	2.7-5	679	0.98	0.5-2	680
		WOFR	Adult	4.47	1.2-8.5	318	9.84	1-21	315
			YOY	2.11	1.4-2.6	409	0.65	0.2-3	409

* Note that the Spring session includes all captures up to June 14th, while the Summer session includes all captures from June 15 and on; † See Table 4 for species codes.

Table 14. Summary of morphological data for the Kananaskis1 RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
1998	Spring	BOTO	Adult	6.93	5-9.5	23	39.28	16.5-76	23
		CSFR	Adult	7.25	7-8	4	34.50	32-40	4
		LTSA	Adult	5.00	5-5	1	9.72	3-19	34
		WOFR	Adult	4.53	2-5.5	15	11.90	6-17.5	15
	Summer	BOTO	Adult	7.29	6.5-9	11	42.27	28-87	11
		CSFR	Adult	6.83	6-7.5	3	35.00	25-40	3
		LTSA	Adult	3.65	2-6.6	120	2.98	2-15.2	120
			YOY	3.40	2.8-3.8	33	2.80	1.5-4.5	33
		WOFR	Adult	3.64	2.8-5	14	7.29	2-17	14
			YOY	2.19	2-2.7	31	2.32	1-4	31
1999	Spring	BOTO	Adult	6.50	6-7	2	31.50	25.5-37.5	2
		CSFR	Adult	5.75	5.5-6	2	24.25	21.5-27	2
		LTSA	Adult	6.10	4.5-7	10	7.65	6.5-10	10
		WOFR	Adult	4.81	4.5-6	8	15.69	12-23.5	8
	Summer	BOTO	Adult	4.30	3.5-6.5	5	13.40	8-32	5
			YOY	2.88	2.5-3	4	5.88	5-6.5	4
		WOFR	Adult	4.33	4-4.5	3	12.67	12.5-13	3
2000	Spring	BOTO	Adult	5.60	3.7-7.5	2	24.25	5.5-43	2
		LTSA	Adult	5.04	4.3-6.4	5	6.00	na	4
		WOFR	Adult	4.60	na	2	9.00	na	1
	Summer	BOTO	Adult	8.40	na	1	71.00	na	1
		WOFR	YOY	1.25	1.25-1.25	1	na	na	0
2001	Spring	BOTO	Adult	7.35	na	11	45.77	na	11
		CSFR	Adult	6.70	6.7-6.7	1	22.50	22.5-22.5	1
		LTSA	Adult	6.10	5.2-8.5	32	6.29	4.5-8.5	32
		WOFR	Adult	4.43	4.2-4.7	7	9.79	8-12.5	7
	Summer	LTSA	Adult	5.15	5.1-5.2	2	4.25	4-4.5	2
		WOFR	Adult	5.10	4.9-5.3	2	14.00	12-16	2
Totals		BOTO	Adult	6.81	3.5-10.5	55	38.57	5.5-87	55
			YOY	2.88	2.5-3	4	5.88	5-6.5	4
		CSFR	Adult	6.77	5.5-8	10	31.40	21.5-40	10
		LTSA	Adult	4.32	2-8.5	170	4.94	2-19	202
			YOY	3.40	2.8-3.8	33	2.80	1.5-4.5	33
		WOFR	Adult	4.33	2-6	51	10.99	2-23.5	50
			YOY	2.16	1.25-2.7	32	2.32	1-4	31

* Note that the Spring session includes all captures up to June 14th, while the Summer session includes all captures from June 15 and on; † See Table 4 for species codes.

Table 15. Summary of morphological data for the Kananaskis2 RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
2002	Spring	BOTO	Adult	5.70	4.8-6.7	4	23.40	11.8-36.5	4
		LTSA	Adult	6.34	5.3-7.8	96	5.07	3-9	96
		WOFR	Adult	4.26	3.8-5.2	5	9.18	6.5-14.9	5
	Summer	BOTO	Adult	5.88	3.3-8	33	23.09	1.2-38	33
			YOY	3.00	na	1	3.00	na	1
		CSFR	Adult	7.80	7.4-8	3	55.00	na	1
		LTSA	Adult	4.80	3.7-6.5	22	3.15	2-6.5	22
			YOY	2.87	2.1-4.8	311	0.59	0.2-1.8	288
		WOFR	Adult	4.44	2.9-5.3	9	11.45	8-16.5	8
			YOY	1.94	1.8-2.2	9	0.61	0.5-0.75	8
2003	Spring	BOTO	Adult	6.77	6-7.8	7	32.44	20.4-48	7
		LTSA	Adult	6.62	4.2-8.1	124	5.72	3.4-8.5	123
		WOFR	Adult	4.62	4-5.4	16	10.36	7.1-16.9	16
	Summer	BOTO	Adult	5.91	4-11.4	19	19.29	5-38.3	19
			YOY	2.00	na	1	0.90	na	1
		CSFR	Adult	8.10	na	1	69.40	na	1
		LTSA	Adult	5.06	2.4-6.9	19	3.64	2-7	19
			YOY	2.73	1.8-4.5	138	0.61	0.3-1.9	137
		WOFR	Adult	4.47	3.8-4.9	3	9.27	1.5-14.1	3
			YOY	1.77	1.4-2.1	198	0.63	0.3-1	195
2004	Spring	LTSA	Adult	6.18	3.3-7.8	55	5.23	1-7.4	55
		WOFR	Adult	4.46	4-4.9	11	9.41	6.8-12.2	11
	Summer	BOTO	Adult	5.25	3.4-7.1	13	15.51	1.1-36.8	13
		LTSA	Adult	5.26	4.5-6.9	12	3.68	2.1-8.2	12
			YOY	2.77	1.9-4.6	151	0.59	0.2-1.8	151
		WOFR	Adult	4.70	4-5.2	5	13.90	8.6-17.6	5
			YOY	1.90	1.8-2	9	0.53	0.3-0.7	9
2005	Spring	BOTO	Adult	4.85	4.7-5	2	12.05	10.5-13.6	2
		LTSA	Adult	5.90	na	1	6.30	na	1
		WOFR	Adult	4.50	na	1	7.90	na	1
	Summer	BOTO	Adult	5.22	3.5-7.6	41	20.27	5-43	41
			YOY	2.53	2.3-2.8	4	2.25	1-5	4
		CSFR	Adult	4.50	na	1	10.00	na	1
		LTSA	Adult	4.46	2.7-6.7	79	4.52	2-14	79
			YOY	2.81	0.7-4.5	305	1.20	1-5	305
		WOFR	Adult	4.43	3.5-5.2	30	13.37	10-20	30
			YOY	1.50	na	1	1.00	na	1

Table continues...

Table 15 continued. Summary of morphological data for the Kananaskis2 RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
2006	Spring	BOTO	Adult	5.67	3.1-8	25	23.08	3.5-69.3	25
		LTSA	Adult	13.39	9.9-15.6	35	5.32	1.6-7.9	39
		WOFR	Adult	4.34	3.5-7.1	47	9.11	5.15-15	47
	Summer	BOTO	Adult	5.68	3.3-7.2	8	26.01	4.3-51	8
			YOY	2.57	1.8-3	3	2.50	0.6-3.5	3
		LTSA	Adult	5.30	na	1	4.40	na	1
			YOY	na	na	0	1.18	0.4-3.7	126
		WOFR	Adult	4.56	3.8-5.2	8	13.13	7.9-18.3	8
			YOY	1.51	0.7-1.7	40	0.41	0.3-0.6	40
2007	Summer	BOTO	Adult	6.00	5-6.7	7	26.60	18.2-40	6
		CSFR	Adult	8.30	na	1	69.70	na	1
		LTSA	Adult	4.75	4.1-6.2	25	3.08	2-5.2	25
			YOY	2.58	1.5-4.5	309	0.59	0.2-2	242
		WOFR	Adult	4.40	4.4-4.4	2	10.80	9.8-11.8	2
			YOY	1.54	1.2-1.7	12	0.38	0.2-0.6	12
2008	Summer	BOTO	Adult	3.98	3.4-5.9	6	4.72	2.5-6.8	5
			YOY	3.20	na	1	3.30	na	1
		LTSA	Adult	5.31	4.1-9	15	4.05	2.3-6.8	13
			YOY	3.22	2.1-4.5	230	1.30	0.7-4.6	229
		WOFR	Adult	5.35	5.2-5.5	2	na	na	0
			YOY	1.50	na	1	0.30	na	1
Totals		BOTO	Adult	5.58	3.1-11.4	165	21.31	1.1-69.3	163
			YOY	2.60	1.8-3.2	10	2.37	0.6-5	10
		CSFR	Adult	7.38	4.5-8.3	6	51.03	10-69.7	4
		LTSA	Adult	6.33	2.4-15.6	484	4.88	1-14	485
			YOY	2.83	0.7-4.8	1444	0.88	0.2-5	1478
		WOFR	Adult	4.45	2.9-7.1	139	10.79	1.5-20	136
			YOY	1.73	0.7-2.2	270	0.58	0.2-1	266

* Note that the Spring session includes all captures up to June 14th, while the Summer session includes all captures from June 15 and on; † See Table 4 for species codes.

Table 16. Summary of morphological data for the Meanook RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
1997	Summer	BCFR	Adult	2.35	2.2-2.7	4	1.04	0.91-1.12	4
		BOTO	Adult	2.20	na	1	1.04	na	1
			YOY	1.70	na	1	0.43	na	1
		WOFR	Adult	4.43	3.8-4.9	6	11.25	5.7-18.49	6
			YOY	2.09	1-2.8	134	1.22	0.63-2.14	134
1998	Summer	BCFR	Adult	2.20	2.1-2.3	3	1.43	1-2	3
			YOY	1.70	na	1	0.60	na	1
		BOTO	Adult	3.35	1.7-5.9	11	10.32	1-37	11
			YOY	1.67	1.2-2.1	332	0.61	0.1-2.5	331
		WOFR	Adult	3.41	2.9-4.7	11	4.81	2.9-11.3	11
			YOY	2.10	1.2-2.8	266	1.01	0.3-2.7	266
1999	Summer	BCFR	Adult	2.35	1.9-2.8	2	0.79	0.38-1.2	2
		BOTO	Adult	3.79	3-5.8	7	6.54	2-21.8	7
		WOFR	Adult	3.71	2.9-5	21	6.02	2.1-16.8	21
			YOY	1.75	1.7-1.8	2	0.45	0.41-0.48	2
2000	Spring	BCFR	Adult	2.68	2.1-3	7	1.37	0.93-1.83	7
		BOTO	Adult	2.59	1.65-4.35	6	3.13	0.57-9.99	6
		WOFR	Adult	3.37	2.5-4.65	14	4.56	1.32-10.98	14
	Summer	BCFR	Adult	2.43	2.25-2.65	3	1.09	0.87-1.38	3
			YOY	1.63	1.5-1.8	6	0.27	0.2-0.4	6
		BOTO	Adult	2.90	2.2-5.7	105	3.16	0.9-21.9	105
			YOY	1.81	1.2-2.1	26	0.84	0.3-2.1	26
		WOFR	Adult	4.35	2.95-5.7	27	10.17	3.1-20.2	27
			YOY	2.19	2-2.7	12	1.09	0.5-1.8	12
2001	Summer	BCFR	Adult	1.95	1.9-2	2	0.63	0.5-0.75	2
			YOY	1.70	na	1	0.50	na	1
		BOTO	Adult	4.33	2.6-7.3	7	10.83	1.5-30.25	7
			YOY	2.00	na	1	0.75	na	1
		WOFR	Adult	4.62	2.9-5.8	29	10.86	0.75-21.75	29
			YOY	2.19	1.25-2.8	287	0.93	0.25-2.3	287
2002	Summer	BCFR	Adult	3.10	na	1	2.50	na	1
		BOTO	Adult	3.34	2.7-5.7	12	4.04	2.5-14	12
		WOFR	Adult	3.51	3-5	31	5.24	1.5-14	28
			YOY	1.94	1-2.8	34	1.54	0.5-3	34
2003	Summer	BCFR	Adult	2.47	2.2-2.7	3	1.00	1-1	3
			YOY	1.51	1.4-1.7	13	0.29	0.25-0.3	13
		BOTO	Adult	4.45	2.5-7	22	12.78	1.5-45.5	21
			YOY	1.40	na	1	0.30	na	1
		WOFR	Adult	3.99	2.9-5.2	118	7.76	2-18	118
			YOY	1.99	0.7-2.8	862	0.92	0.3-10	856

Table continues ...

Table 16 continued. Summary of morphological data for the Meanook RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
2004	Summer	BCFR	Adult	4.50	na	1	8.70	na	1
			YOY	1.28	1.2-1.3	4	0.40	0.1-0.5	4
		BOTO	Adult	2.70	2.3-2.9	3	2.34	1.03-3.5	3
		WOFR	Adult	3.80	2.9-5.4	35	6.62	1.5-21	35
			YOY	1.92	1-2.8	257	1.02	0.5-3.3	257
2005	Summer	BCFR	Adult	2.00	2-2	3	1.67	1-2	3
		BOTO	Adult	4.50	2.3-7.2	10	14.24	4-33.7	10
		WOFR	Adult	4.25	2.9-6	67	10.03	1.1-22	68
			YOY	2.26	1.4-3.7	372	1.46	0.2-7	371
2006	Spring	BCFR	Adult	3.10	na	1	3.00	na	1
		BOTO	Adult	6.75	3-9	31	33.82	2.25-50	31
		WOFR	Adult	3.95	2-5.5	71	6.88	1-14	71
	Summer	BCFR	Adult	3.00	na	1	2.00	na	1
		BOTO	Adult	6.02	4.2-9.1	18	21.86	6.5-47	18
		WOFR	Adult	4.30	2.9-6	77	9.54	0.5-23	77
			YOY	2.20	1-2.8	383	1.17	0.2-10	383
2008	Summer	BCFR	Adult	2.54	1.9-2.9	5	1.52	1-2	5
			YOY	1.45	1.4-1.5	2	0.35	0.2-0.5	2
		BOTO	Adult	5.16	3.8-6.8	17	16.28	4.9-39	17
		WOFR	Adult	3.78	2.9-7	195	7.30	0.9-32.5	194
			YOY	1.98	0.5-2.8	569	1.07	0.4-7.5	569
Totals		BCFR	Adult	2.51	1.9-4.5	36	1.55	0.38-8.7	36
			YOY	1.51	1.2-1.8	27	0.33	0.1-0.6	27
		BOTO	Adult	4.05	1.65-9.1	250	11.13	0.57-50	249
			YOY	1.68	1.2-2.1	361	0.62	0.1-2.5	360
		WOFR	Adult	3.97	2-7	702	7.89	0.5-32.5	699
			YOY	2.07	0.5-3.7	3178	1.07	0.2-10	3171

* Note that the Spring session includes all captures up to June 14th, while the Summer session includes all captures from June 15 and on; † See Table 4 for species codes.

Table 17. Summary of morphological data for the Saskatoon Island RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
1999	Spring	BCFR	Adult	2.80	2.7-2.9	2	2.50	2.5-2.5	2
		WOFR	Adult	4.77	4-5.7	56	12.59	1.75-19.5	56
	Summer	BCFR	Adult	2.80	2.5-3	3	2.27	2-2.5	3
			YOY	1.50	na	1	0.50	na	1
		WOFR	Adult	4.80	3-6	30	13.87	4-21	30
			YOY	2.58	2.3-2.9	19	2.79	2-3.5	19
2000	Spring	BCFR	Adult	2.51	1.9-2.9	10	2.92	1.8-4	10
		WOFR	Adult	4.89	3.8-5.7	15	11.66	4-20	17
	Summer	BCFR	Adult	1.90	na	1	2.50	na	1
			YOY	1.66	1.5-2	5	1.26	1-1.8	6
		BOTO	Adult	7.50	5-10	2	12.25	12-12.5	2
		WOFR	Adult	4.44	2.7-6	7	10.57	2-19	7
			YOY	2.63	2.2-2.9	17	3.12	2.5-3.5	17
2001	Spring	BCFR	Adult	1.70	na	1	1.00	na	1
		WOFR	Adult	4.74	2.5-6.5	16	10.47	1.5-18	16
	Summer	BCFR	Adult	2.00	2-2	2	0.75	0.5-1	2
		BOTO	Adult	7.17	6.5-8	3	41.67	38-47	3
		WOFR	Adult	4.43	3-6.5	46	11.95	2-26	46
			YOY	2.00	na	1	1.50	na	1
2002	Spring	BCFR	Adult	2.35	2.2-2.5	2	0.75	0.5-1	2
		WOFR	Adult	4.77	3.2-6	52	12.10	4-26	48
	Summer	BCFR	Adult	2.50	2.5-2.5	2	1.00	1-1	2
		WOFR	Adult	4.40	3-7	85	9.42	2-20	85
			YOY	2.73	2.4-5	28	2.09	1-3.5	28
2003	Spring	BCFR	Adult	2.56	2.3-2.8	8	3.04	2.2-4.7	8
		WOFR	Adult	4.71	3.8-5.7	19	9.16	5-19	19
	Summer	WOFR	Adult	4.66	3.2-5.7	51	12.19	3-20	51
			YOY	2.41	1.8-2.8	97	2.72	1.4-5.5	97
2004	Spring	WOFR	Adult	2.96	2.4-4.7	28	2.46	1-8.5	28
	Summer	WOFR	Adult	4.23	3-5.1	16	10.28	2.5-14	16
			YOY	2.84	2.7-2.9	5	4.00	1.5-8.5	5
2005	Spring	BCFR	Adult	2.50	na	1	1.10	na	1
		WOFR	Adult	3.90	2.1-5.7	7	4.83	1.6-10.1	7
	Summer	BCFR	Adult	2.00	na	1	1.00	na	1
			YOY	1.50	na	1	0.90	na	1
		BOTO	Adult	4.42	3.8-5.5	10	9.65	6-17	10
		WOFR	Adult	4.13	3.1-5.2	10	5.57	1.5-13	10
			YOY	2.35	2.2-2.5	4	1.00	1-1	4
Totals		BCFR	Adult	2.47	1.7-3	33	2.30	0.5-4.7	33
			YOY	1.61	1.5-2	7	1.12	0.5-1.8	8
		BOTO	Adult	5.38	3.8-10	15	16.40	6-47	15
		WOFR	Adult	4.48	2.1-7	438	10.58	1-26	436
			YOY	2.51	1.8-5	171	2.65	1-8.5	171

* Note that the Spring session includes all captures up to June 14th, while the Summer session includes all captures from June 15 and on; † See Table 4 for species codes.

Table 18. Summary of morphological data for the Lesser Slave Lake RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
1997	Summer	BCFR	Adult	2.33	2.2-2.6	3	0.53	0.5-0.6	3
			YOY	1.40	1.3-1.5	2	0.35	0.2-0.5	2
		BOTO	Adult	5.23	3.2-6.6	4	17.10	4.3-25.1	4
			YOY	1.30	na	1	0.40	na	1
		WOFR	Adult	4.63	4.2-5.5	4	13.25	10.4-17.2	4
			YOY	2.10	0.8-3.4	63	1.16	0.3-4.5	63
1998	Spring	BCFR	Adult	2.25	2.2-2.3	2	1.60	1-2.2	2
		BOTO	Adult	5.27	2.5-7.2	7	21.59	4-51	7
		CATO	Adult	3.10	na	1	6.10	na	1
		WOFR	Adult	3.88	2.4-4.9	9	5.58	1.6-10.7	9
	Summer	BCFR	Adult	2.40	na	1	0.90	na	1
		BOTO	Adult	5.11	3.4-6.1	11	16.60	5.5-26.4	11
			YOY	1.63	1.3-2.2	4	1.45	0.7-3.1	4
		WOFR	Adult	4.45	3.6-6.9	13	8.39	2-13.1	12
			YOY	2.15	1-3.3	10	1.23	0.4-3.5	10
1999	Spring	BCFR	Adult	2.77	2.5-3	16	1.75	1-3	16
		BOTO	Adult	4.54	2.8-7.3	23	12.83	2-32	23
		WOFR	Adult	4.11	2.5-5.5	67	7.46	1-17	67
	Summer	BCFR	Adult	2.97	2.7-3.2	3	2.10	2-2.2	2
			YOY	1.54	1.1-1.8	38	0.44	0.1-1	38
		BOTO	Adult	4.26	3.2-6.6	89	8.94	2-40	89
			YOY	2.10	1.9-2.3	2	2.80	0.6-5	2
		WOFR	Adult	4.52	3.5-5.7	34	10.23	5-19	33
			YOY	2.55	1.8-3.4	18	2.08	0.7-7.4	17
2000	Spring	BCFR	Adult	2.19	1.7-3	17	1.03	0.5-2	17
		BOTO	Adult	4.97	2.6-7.9	13	13.50	1-42	13
		WOFR	Adult	4.54	2.6-6.1	15	8.40	0.5-20	15
	Summer	BCFR	Adult	2.86	2.7-3	5	2.20	1.5-2.5	5
			YOY	1.58	1.4-1.8	4	0.73	0.5-1	4
		BOTO	Adult	4.43	3.1-6.5	27	9.05	2.5-20.5	27
			YOY	1.80	1.1-2.6	42	1.24	0.25-3	42
		WOFR	Adult	4.91	4.1-6.1	12	12.71	6-32.5	12
			YOY	2.04	0.9-3	16	1.77	0.25-4	16
2001	Summer	BCFR	Adult	2.48	2-3.3	12	3.42	1-6	12
			YOY	1.66	1.4-1.9	16	2.85	1-4	13
		BOTO	Adult	5.56	3.3-8.2	70	26.97	4-72	70
			YOY	2.11	1.4-2.9	748	3.93	0.5-6.5	724
		WOFR	Adult	4.30	3.5-5.3	41	12.93	6-24	41
			YOY	2.28	1.6-3.4	42	4.52	1.5-10	41

Table continues...

Table 18 continued. Summary of morphological data for the Lesser Slave Lake RANA site.

Year	Session*	Species†	Age class	Snout-to-vent length (cm)			Weight (g)		
				Mean	Range	n	Mean	Range	n
2002	Spring	BCFR	Adult	2.39	1.2-3.1	282	1.40	0.25-2.5	282
		BOTO	Adult	6.22	2.5-7.3	20	29.79	1.5-55	20
		WOFR	Adult	4.26	2-5.7	119	9.56	1-21	119
	Summer	BCFR	Adult	2.55	2-3.2	15	1.67	1-3.5	15
			YOY	1.70	1.5-1.9	2	0.75	0.5-1	2
		BOTO	Adult	5.01	3.2-7.2	22	16.68	3.5-40	22
			YOY	2.50	1.5-3	111	2.08	1-3	111
		WOFR	Adult	4.37	3.7-5.6	29	12.02	7-24	29
			YOY	2.35	1.8-3.3	47	1.82	1-4.5	47
2003	Spring	BCFR	Adult	2.31	1.5-3.2	38	1.20	0.5-2.5	38
		BOTO	Adult	5.06	2.2-7.6	27	18.80	1.5-51.5	27
		WOFR	Adult	3.63	2-6.4	224	6.69	0.5-27	224
	Summer	BCFR	Adult	2.34	2-3.6	8	0.94	0.5-1.5	8
			YOY	1.41	0.5-1.9	10	0.51	0.2-2	10
		BOTO	Adult	5.13	3.3-7.5	48	16.39	5-50	48
			YOY	1.95	1.3-2.4	4	0.94	0.25-2	4
		WOFR	Adult	4.35	3.5-5.2	24	10.70	2.5-20	23
			YOY	2.68	1-3.4	699	2.10	0.5-4.5	696
2004	Spring	BCFR	Adult	2.27	1.6-3.3	126	1.23	0.5-3	126
		BOTO	Adult	5.25	2-7.8	67	18.60	0.75-53	65
		WOFR	Adult	3.32	2-5.9	212	4.76	1.5-17	212
	Summer	BCFR	Adult	2.40	na	1	1.50	na	1
		BOTO	Adult	4.20	3.1-7.2	171	9.17	3-43	140
			YOY	2.55	1.2-3	13	3.57	1-6	7
		WOFR	Adult	4.00	3.7-4.4	3	5.67	5-7	3
			YOY	2.47	2.3-2.7	6	2.17	1-3	6
2005	Spring	WOFR	Adult	3.67	2.4-4.4	3	6.67	3-9	3
Totals		BCFR	Adult	2.38	1.2-3.6	529	1.39	0.25-6	528
			YOY	1.55	0.5-1.9	72	0.93	0.1-4	69
		BOTO	Adult	4.77	2-8.2	599	15.11	0.75-72	566
			YOY	2.15	1.1-3	925	3.54	0.25-6.5	895
		CATO	Adult	3.10	na	1	6.10	na	1
		WOFR	Adult	3.86	2-6.9	809	7.60	0.5-32.5	806
			YOY	2.58	0.8-3.4	901	2.11	0.25-10	896

* Note that the Spring session includes all captures up to June 14th, while the Summer session includes all captures from June 15 and on.

† See Table 4 for species codes.

FIGURES

Figure 1. Distribution of RANA project pitfall sites in Alberta, Canada. Note that pitfall trapping was not used at the Beaverhill Lake site, but this site was used during surveys and for educational purposes.

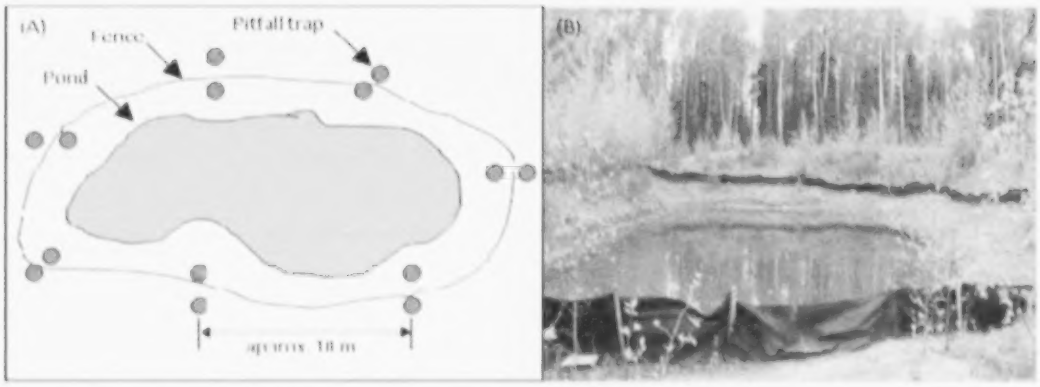

Figure 2. Schematic layout of fencing and pitfall traps (A); example of layout (B).

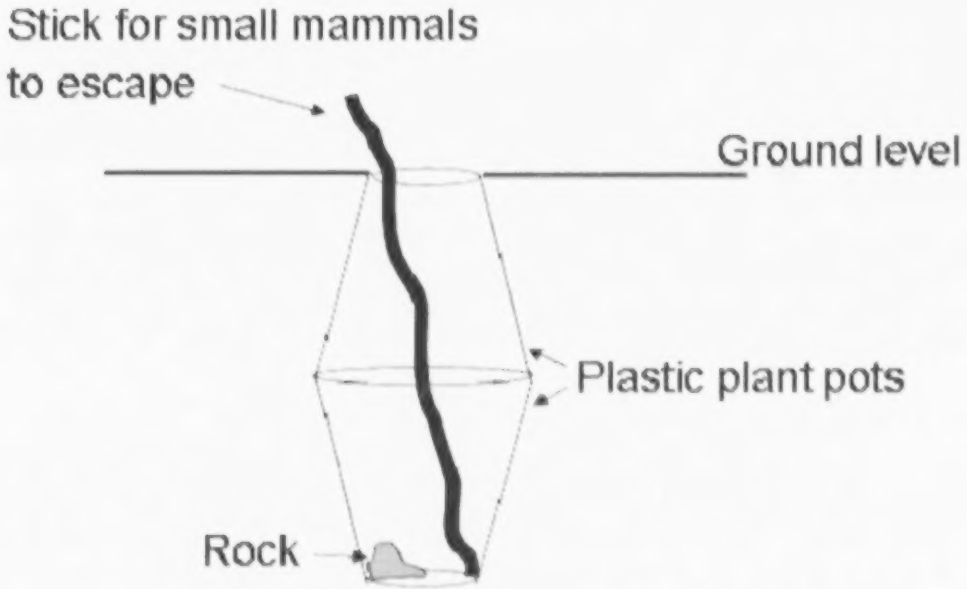

Figure 3. Close-up of pitfall trap design. Note that the traps were composed of two plastic plant pots with their openings placed together and the bottom cut out of the

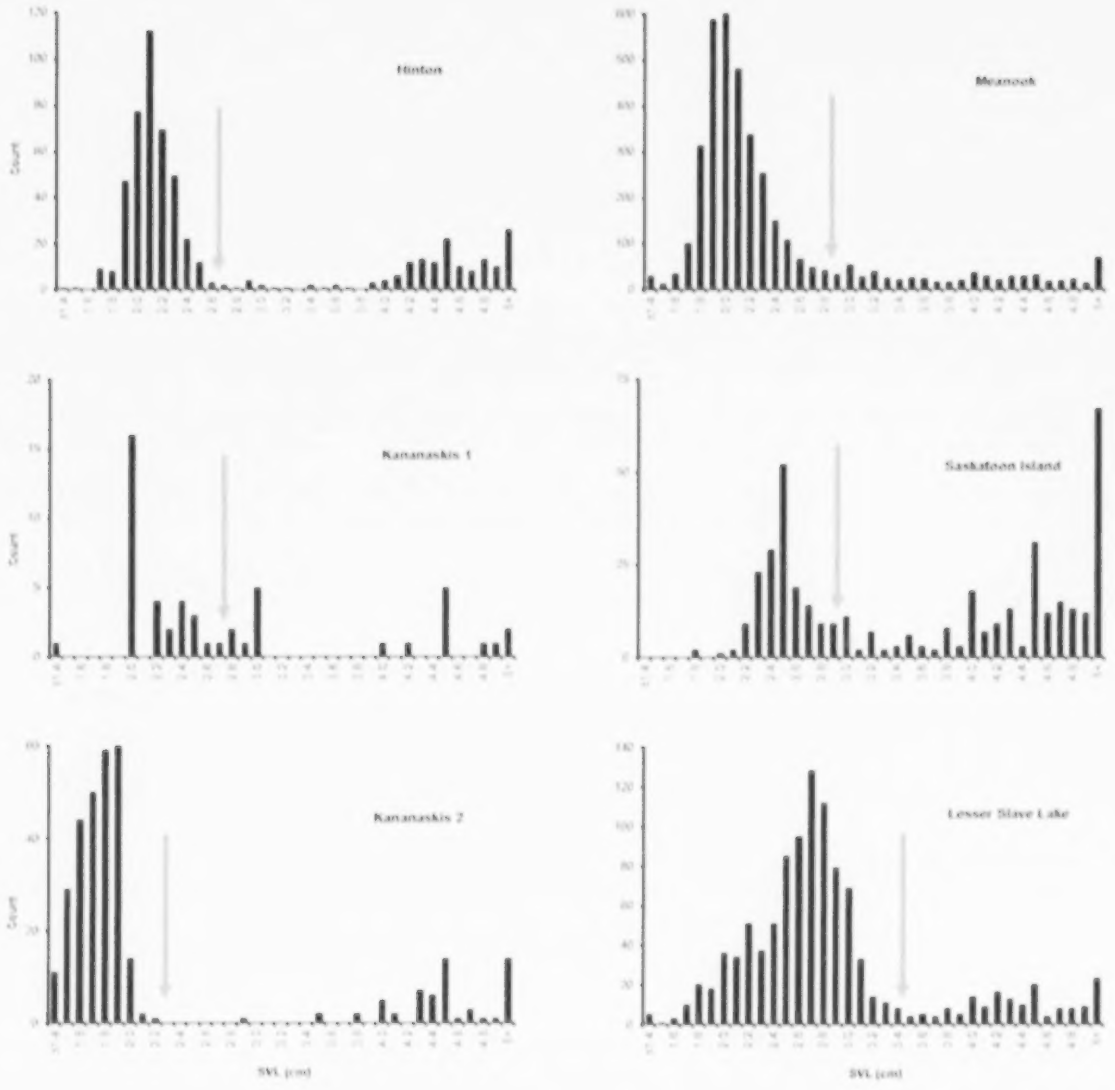

Figure 4. Distribution of SVLs for wood frogs captured after June 14 summarized by site and year. Potential break-points in the size distribution thought to be related to differences between metamorphs and adults are indicated by arrows. Note differences in scale on y-axis.

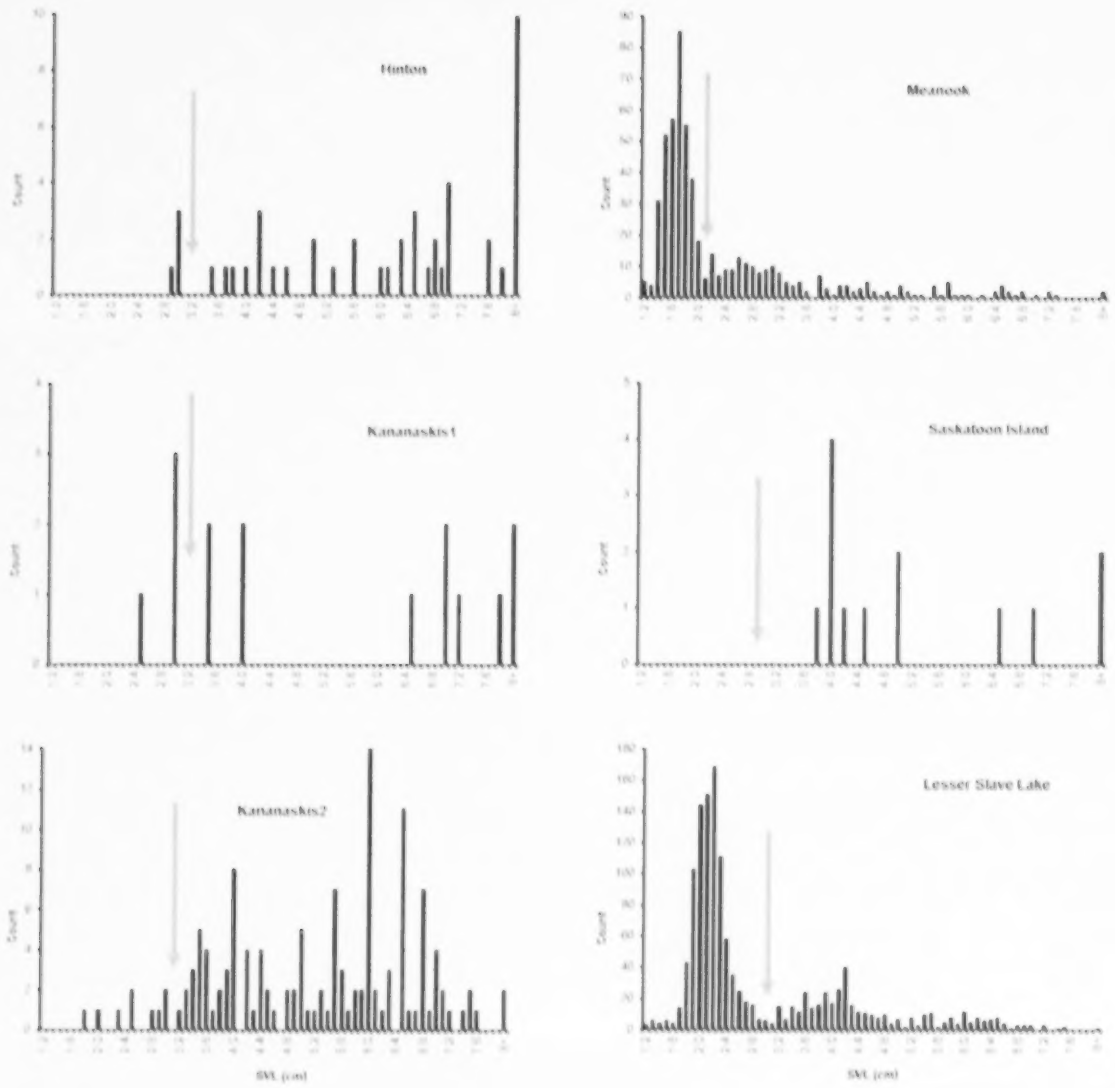

Figure 5. Distribution of SVLs for boreal toads captured in July and later summarized by site and year. Potential break-points in the size distribution thought to be related to differences between metamorphs and adults are indicated by arrows. Note differences in scale on y-axis.

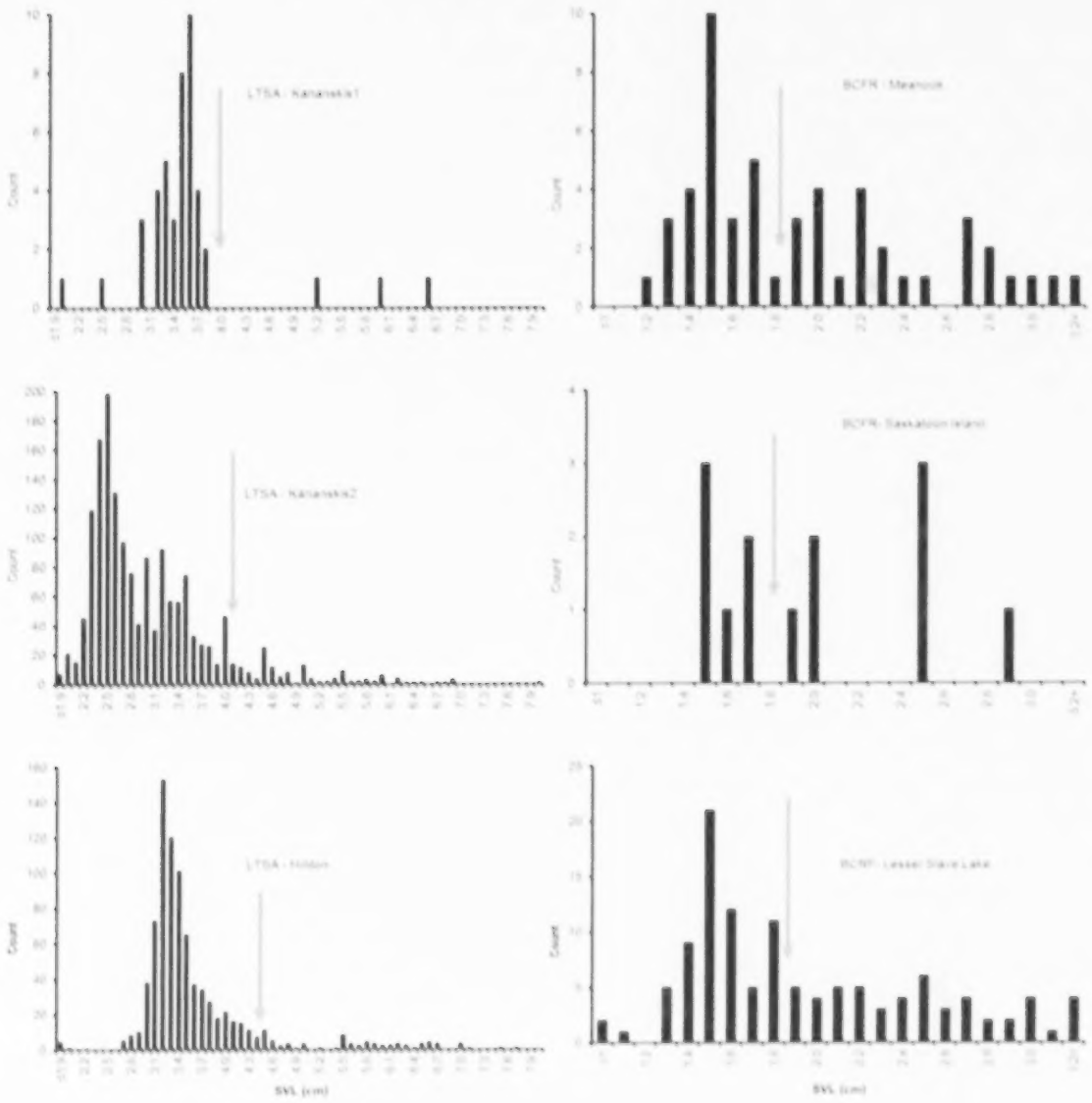

Figure 6. Distribution of SVLs for long-toed salamanders captured in August and later and boreal chorus frogs captured in July and later summarized by site and year. Potential break-points in the size distribution thought to be related to differences between metamorphs and adults are indicated by arrows. Note differences in scale on y-axis.

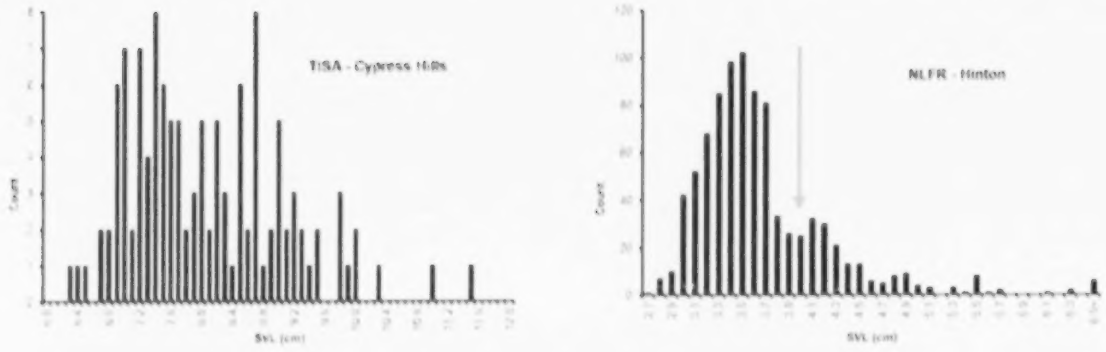

Figure 7. Distribution of SVLs for tiger salamanders captured in August and later, and northern leopard frogs captured June 23 and later, summarized by site and year. Potential break-points in the size distribution thought to be related to differences between metamorphs and adults are indicated by arrows; there is no discernible pattern for tiger salamanders. Note differences in scale on y-axis.

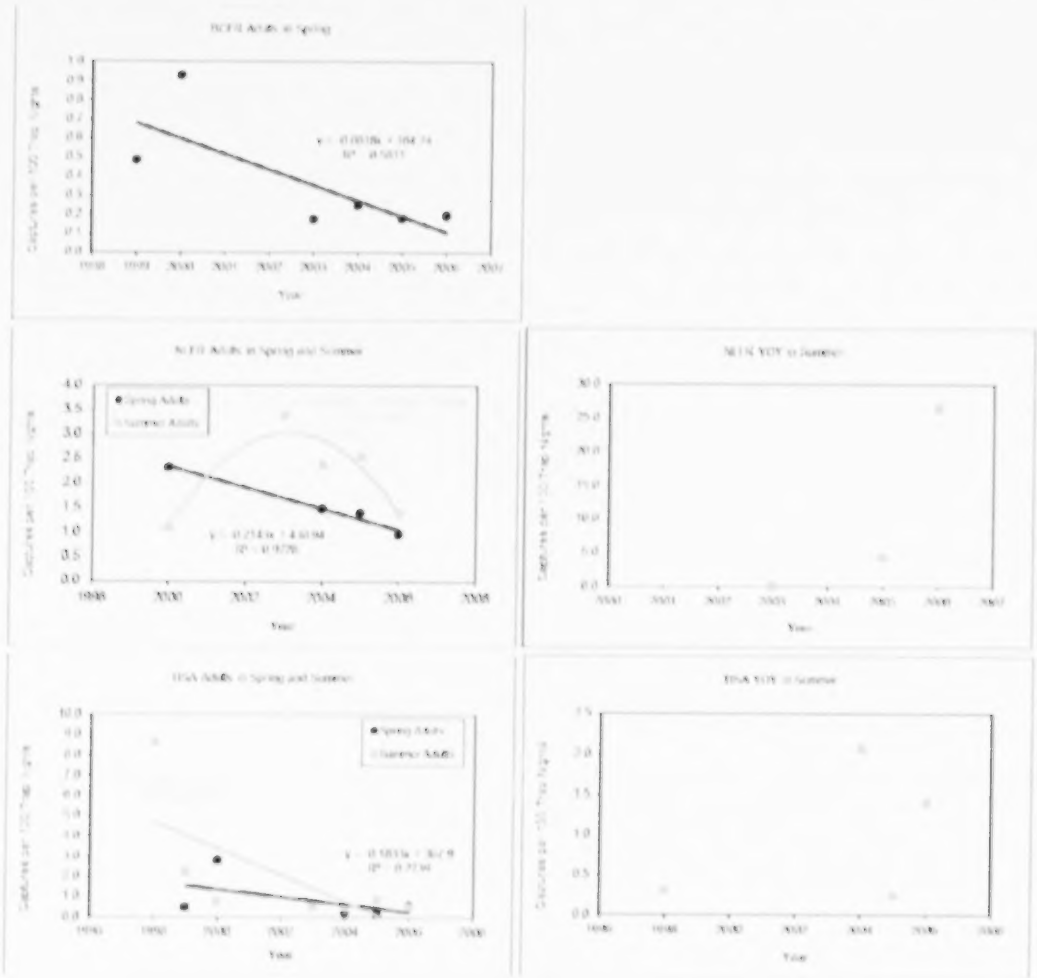

Figure 8. Changes in relative abundance of amphibian species over time at the Cypress Hills RANA site. Note that abundance is estimated separately for spring (up to June 14th) and summer (after June 14th) periods, and by age classes (YOY and adult).

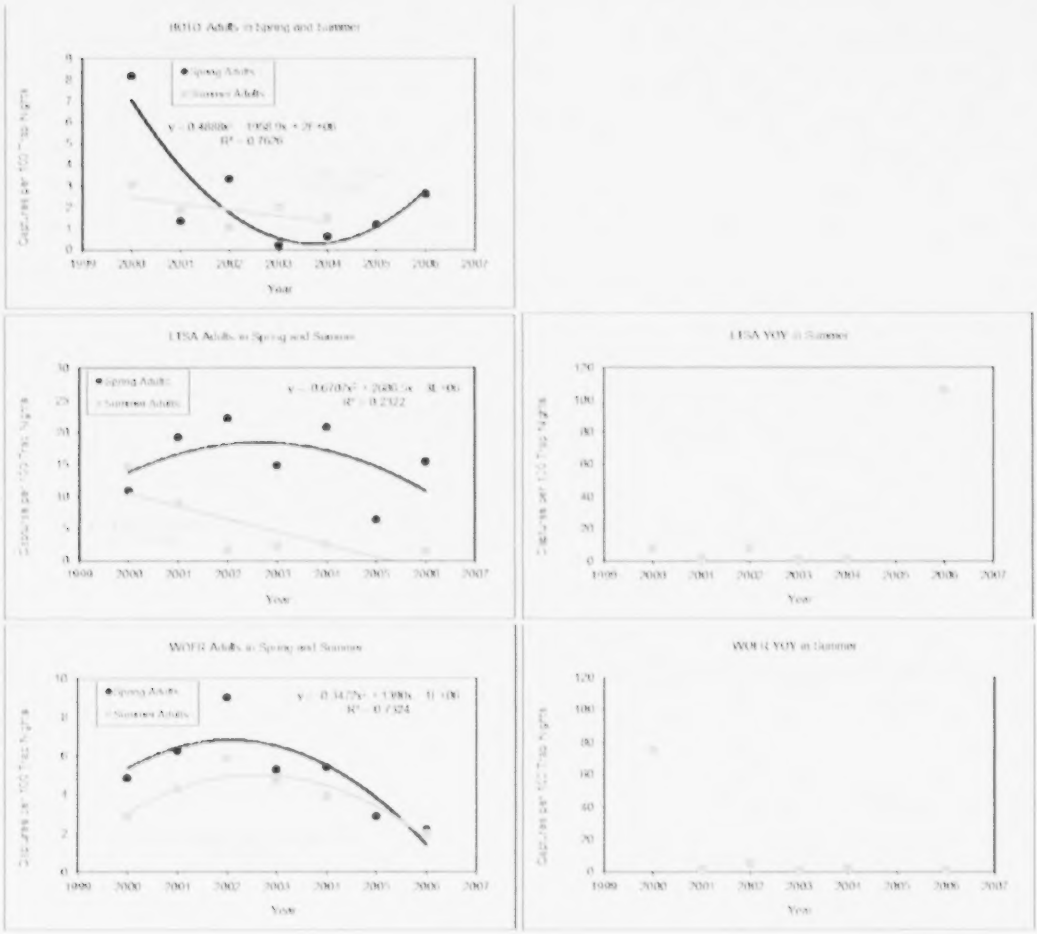

Figure 9. Changes in relative abundance of amphibian species over time at the Hinton RANA site. Note that abundance is estimated separately for spring (up to June 14th) and summer (after June 14th) periods, and by age classes (YOY and adult).

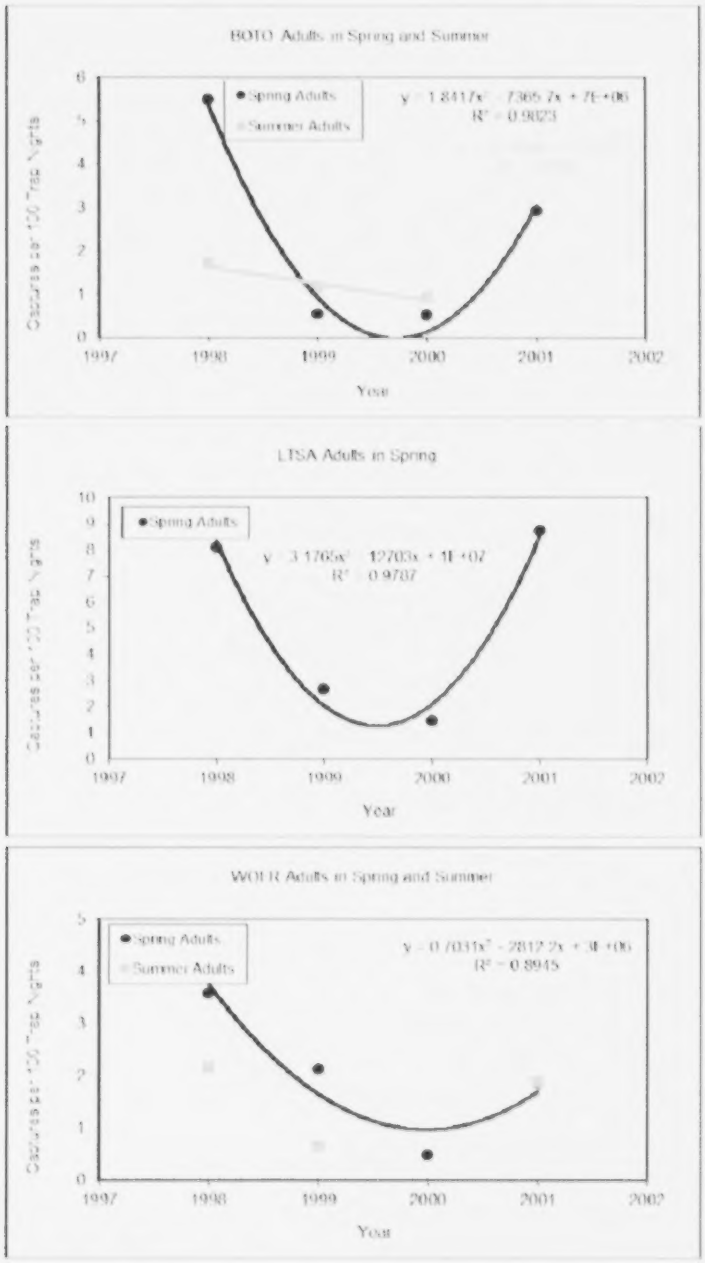

Figure 10. Changes in relative abundance of amphibian species over time at the Kananaskis1 RANA site. Note that abundance is estimated separately for spring (up to June 14th) and summer (after June 14th) periods, and by age classes (YOY and adult).

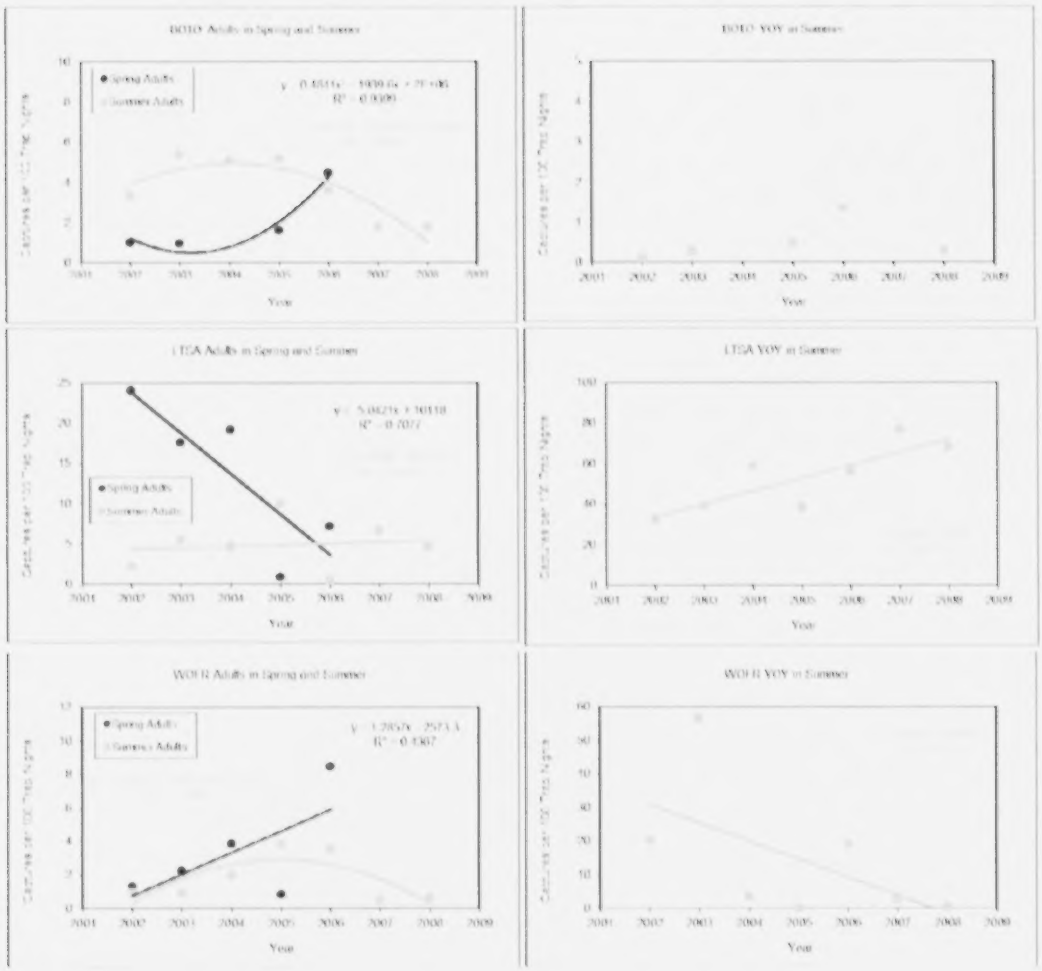

Figure 11. Changes in relative abundance of amphibian species over time at the Kananaskis2 RANA site. Note that abundance is estimated separately for spring (up to June 14th) and summer (after June 14th) periods, and by age classes (YOY and adult).

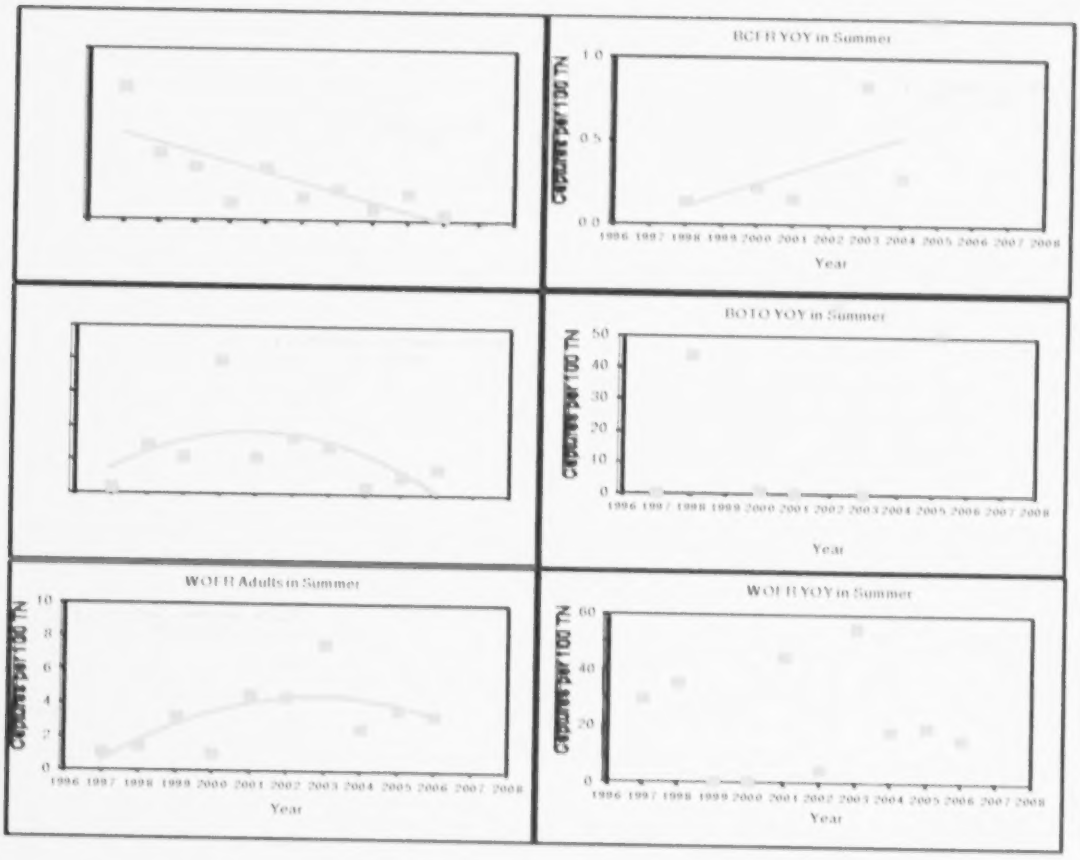

Figure 12. Changes in relative abundance of amphibian species over time at the Meanook RANA site. Note that abundance is estimated separately for spring (up to June 14th) and summer (after June 14th) periods, and by age classes (YOY and adult).

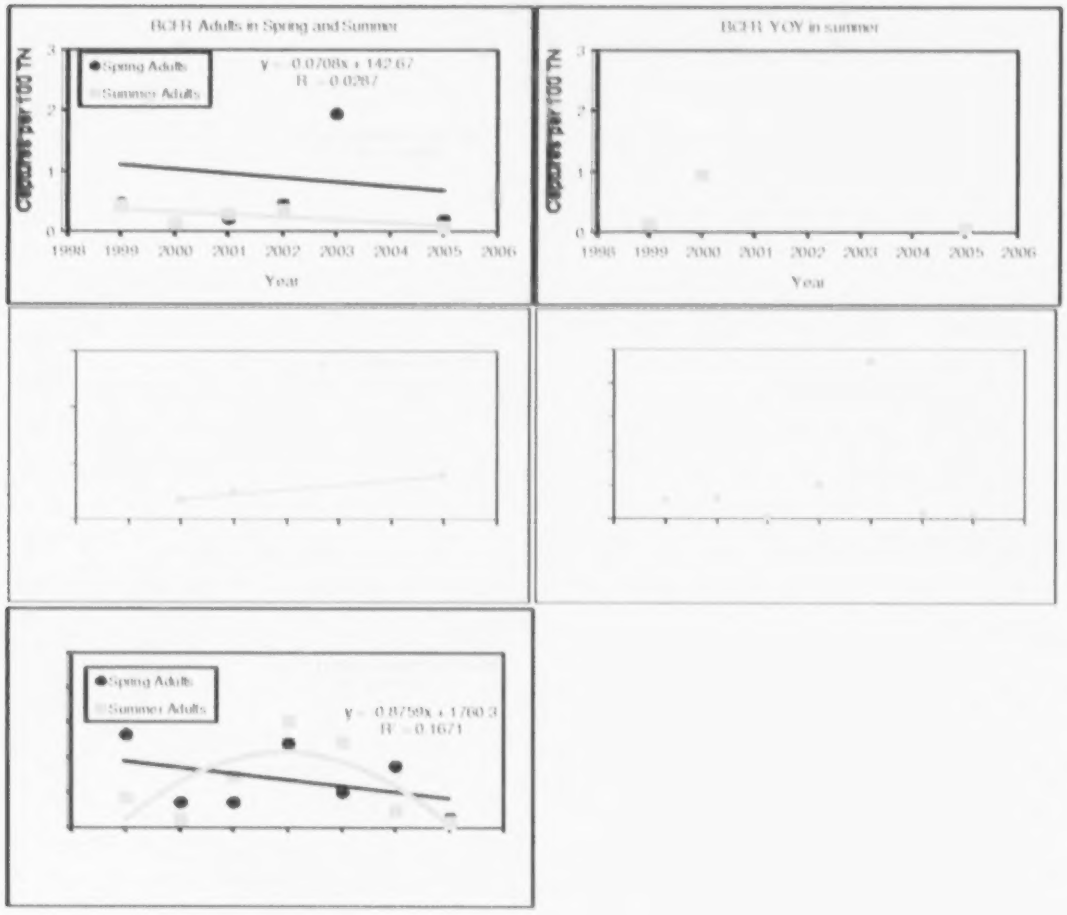

Figure 13. Changes in relative abundance of amphibian species over time at the Saskatoon Island RANA site. Note that abundance is estimated separately for spring (up to June 14th) and summer (after June 14th) periods, and by age classes (YOY and adult). There were no BOTO YOY captured at this site.

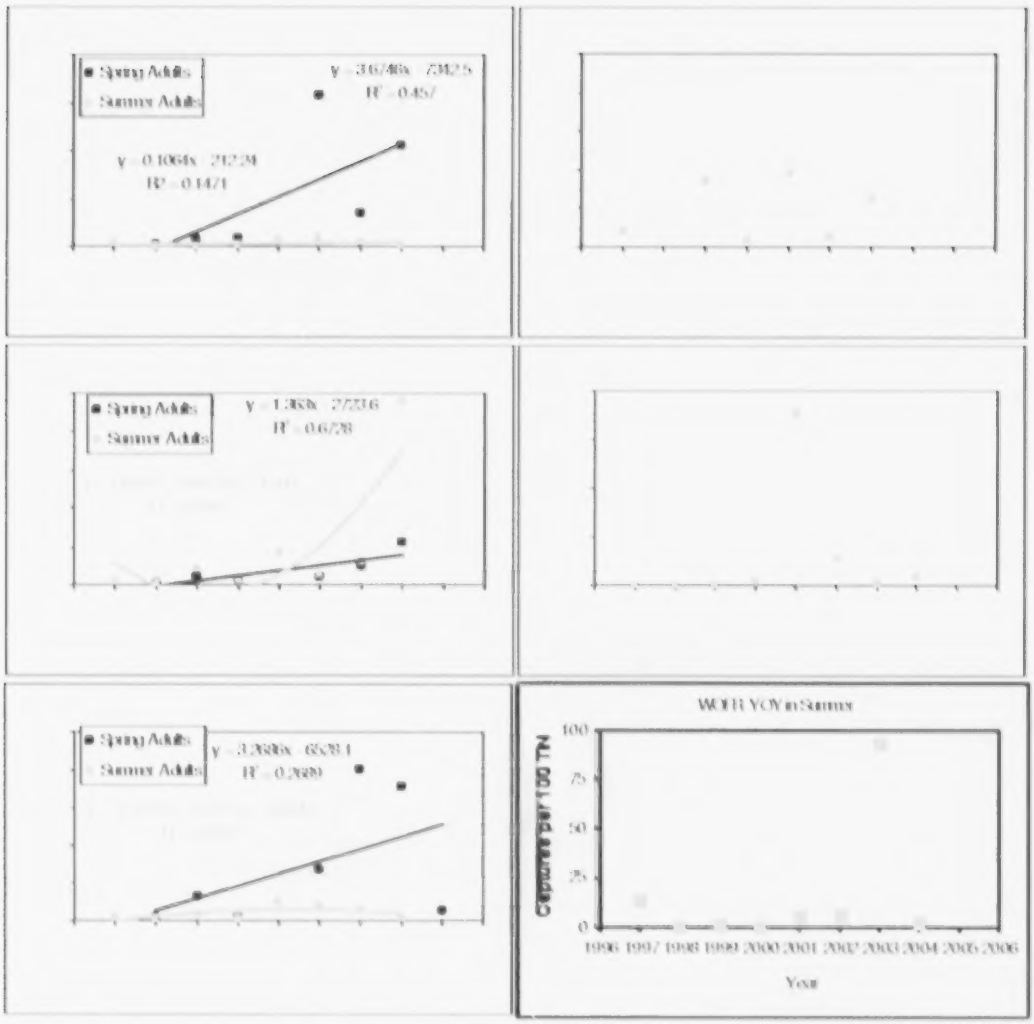

Figure 14. Changes in relative abundance of amphibian species over time at the Lesser Slave Lake RANA site. Note that abundance is estimated separately for spring (up to June 14th) and summer (after June 14th) periods, and by age classes (YOY and adult).

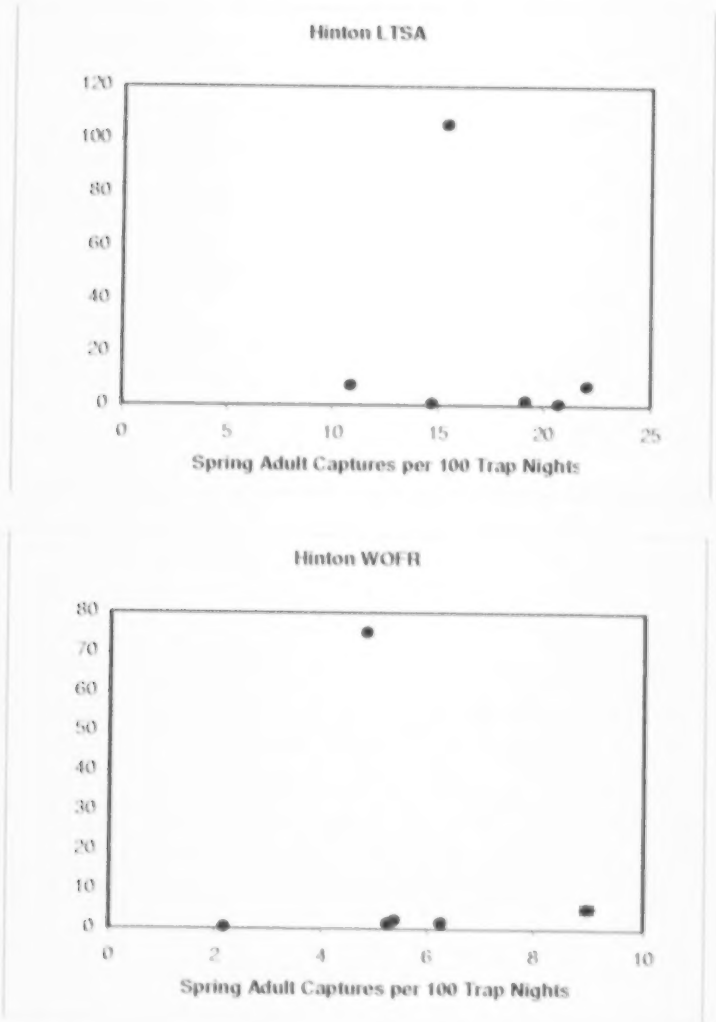

Figure 15. Relationship between spring adult captures and summer YOY captures at the Hinton RANA project site.

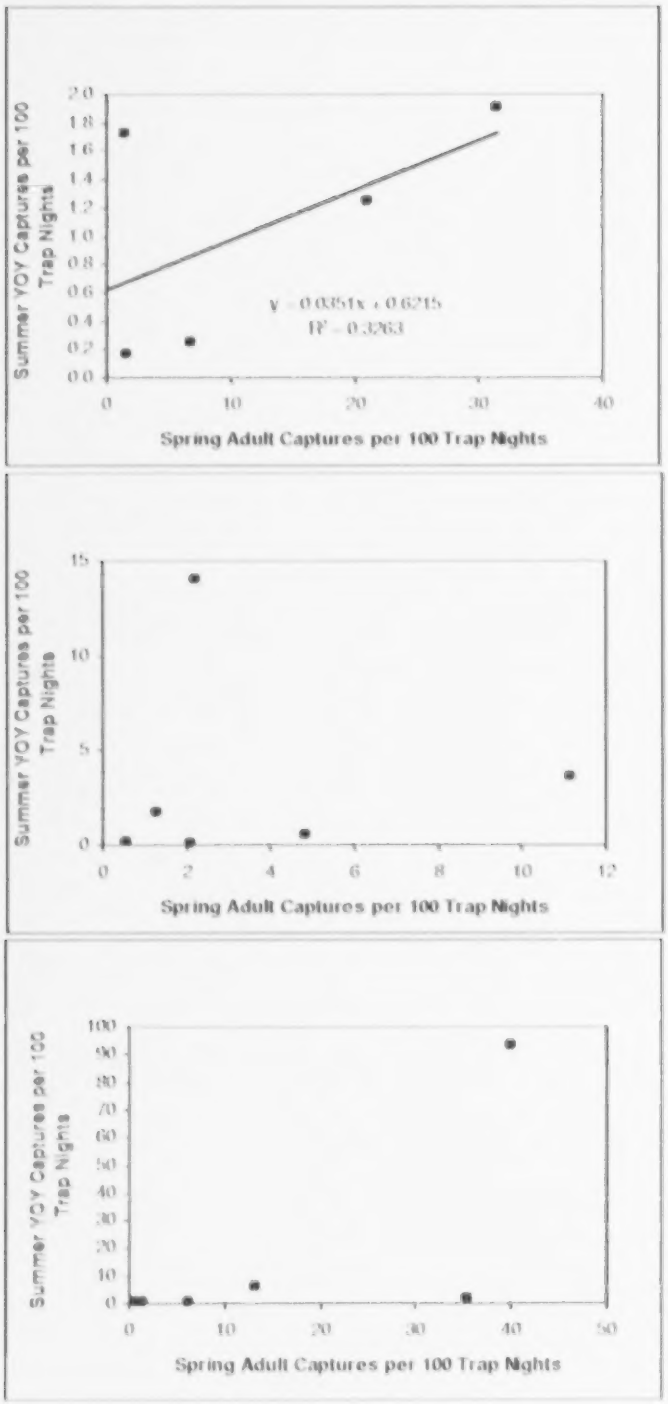
Summer YOY Captures per 100 Trap Nights
Spring Adult Captures per 100 Trap Nights
y = 0.0351x + 0.6215
R² = 0.3263
Summer YOY Captures per 100 Trap Nights
Spring Adult Captures per 100 Trap Nights
Summer YOY Captures per 100 Trap Nights
Spring Adult Captures per 100 Trap Nights

Figure 16. Relationship between spring adult captures and summer YOY captures at the Lesser Slave Lake RANA project site.

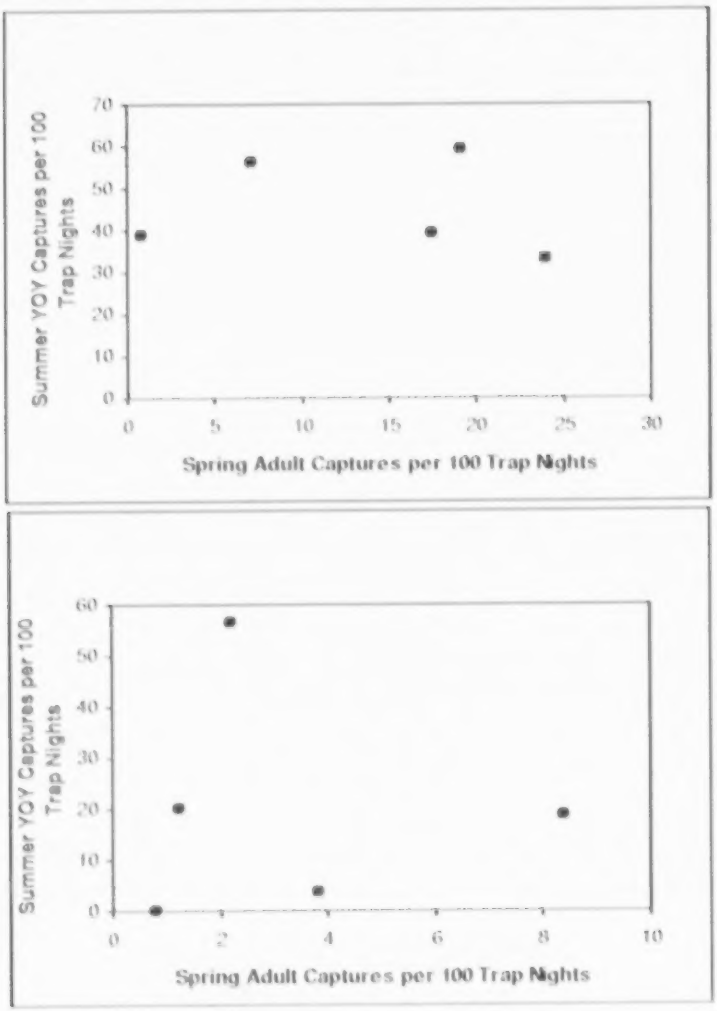

Figure 17. Relationship between spring adult captures and summer YOY captures at the Kananaskis2 RANA project site.

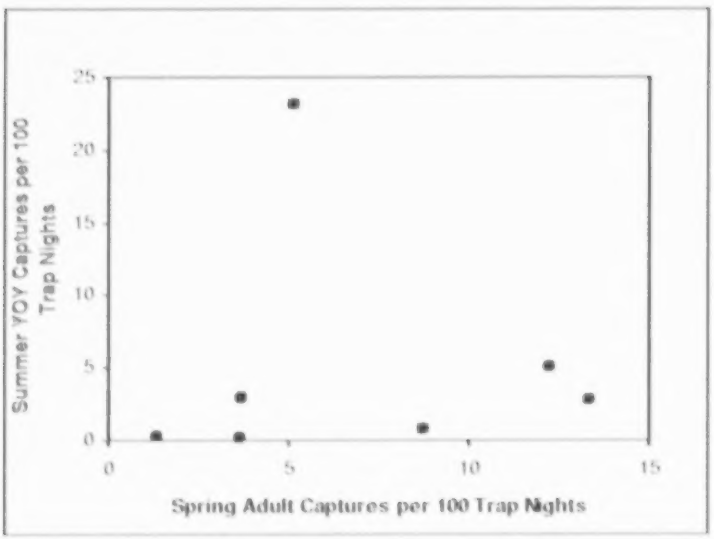

Figure 18. Relationship between spring adult captures and summer YOY captures at the Saskatoon Island RANA project site.

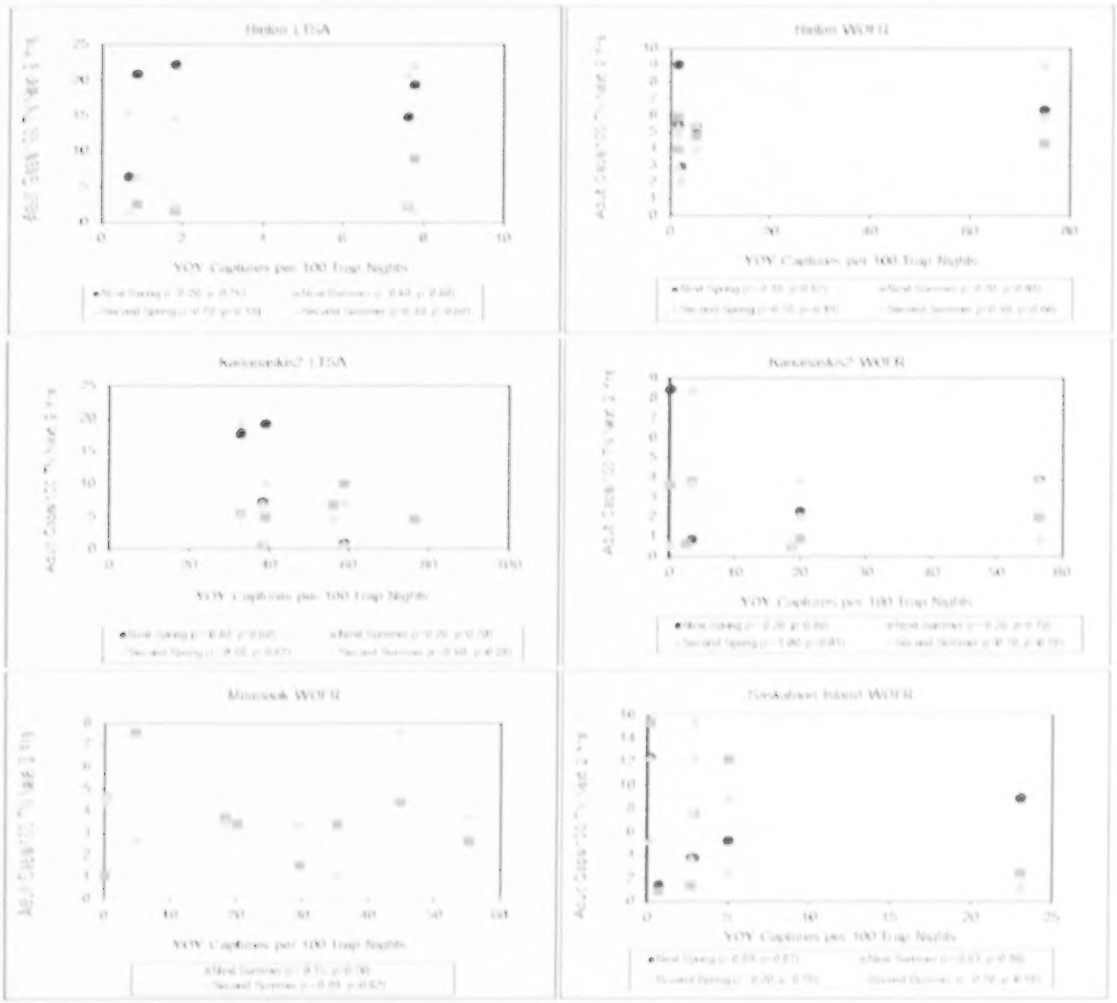

Figure 19a. Relationship between YOY populations in a year and adult populations in the subsequent two years, by site and species. Statistics related to each relationship are provided on the individual graphs. Note: TN = trap nights.

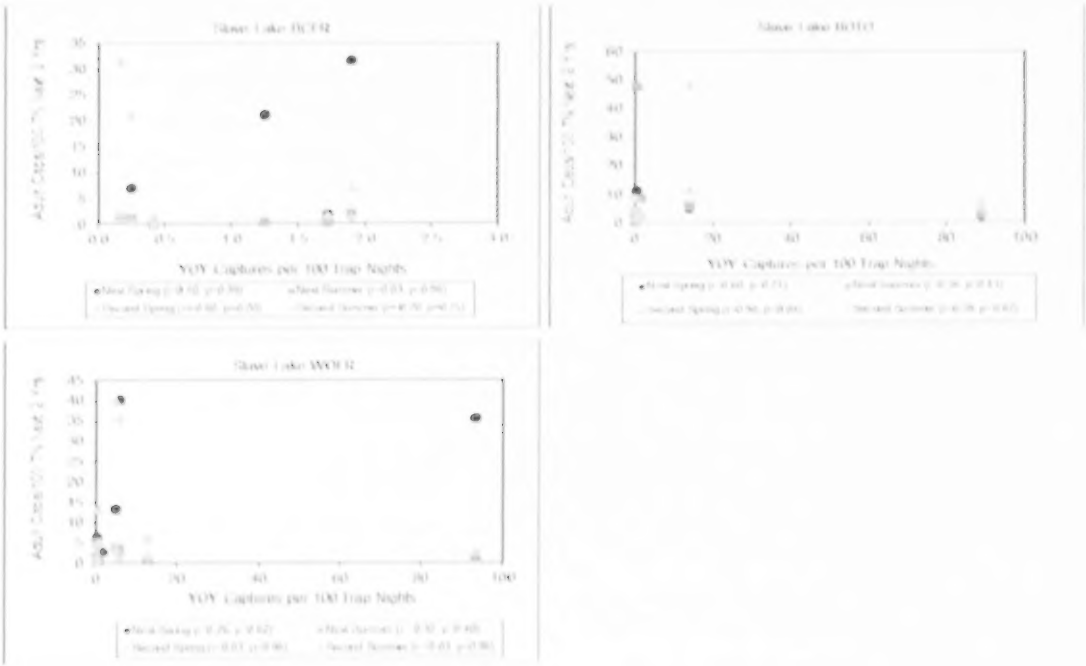

Figure 19b. Relationship between YOY populations in a year and adult populations in the subsequent two years, by site and species. Statistics related to each relationship are provided on the individual graphs. Note: TN = trap nights.

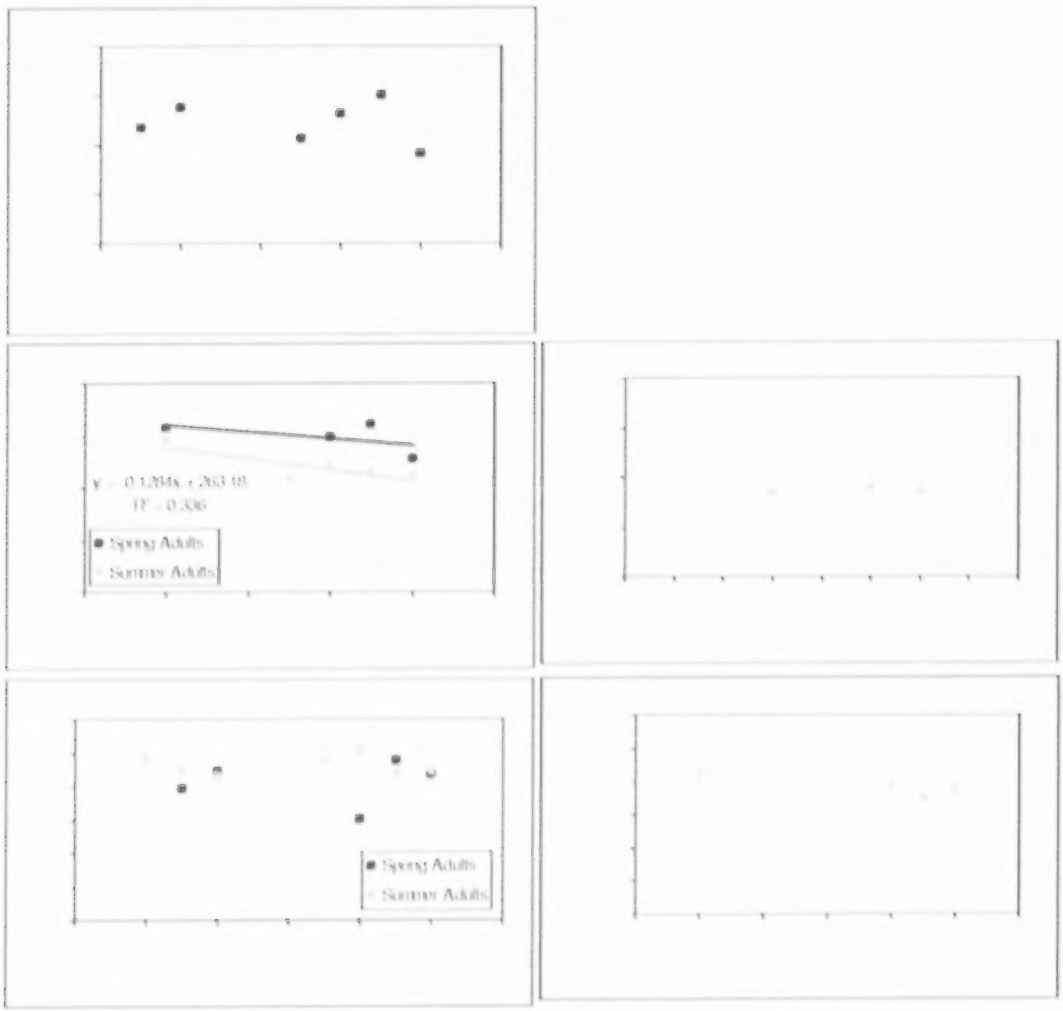

Figure 20. Trends in SVL over time at Cypress Hills. There were no real trends in SVL for BCFR or TISA adults. Note that sample sizes for BCFR were small and that only 2 YOY BCFR were caught at this site.

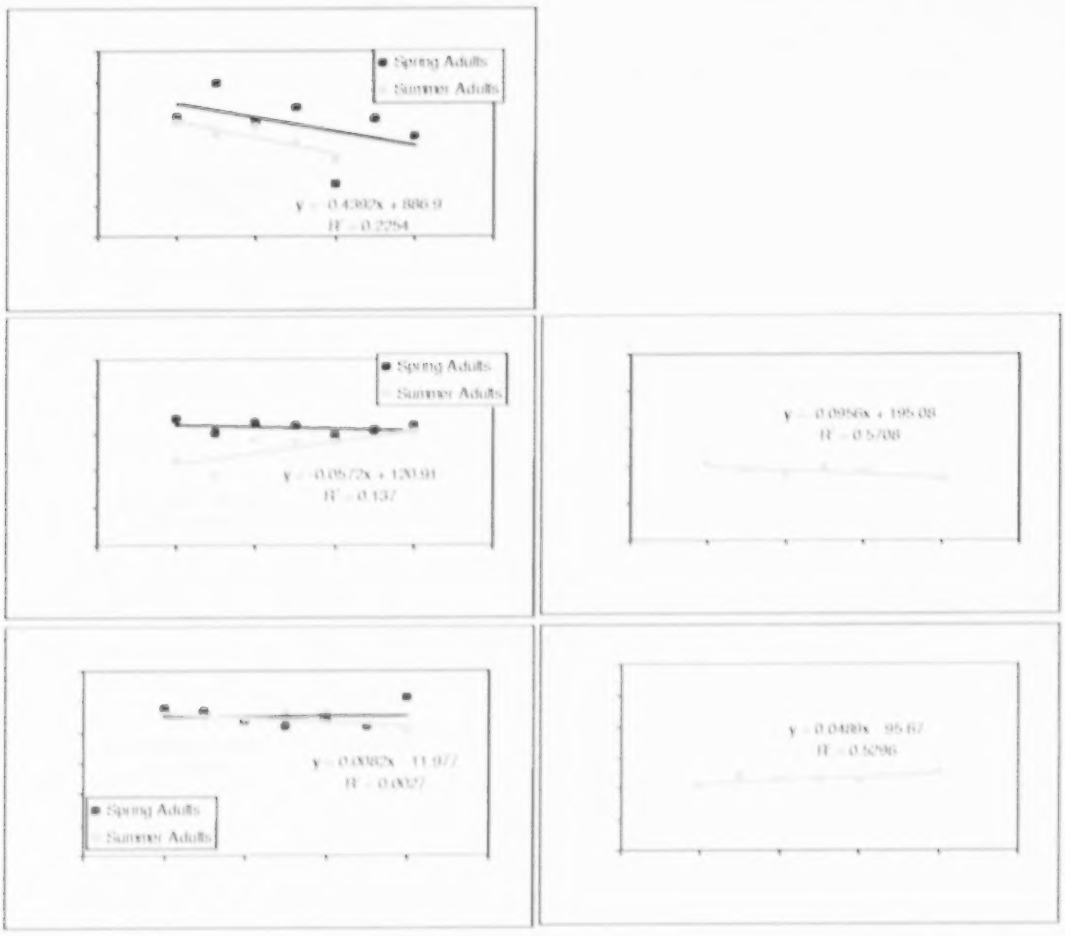

Figure 21. Trends in SVL over time at Hinton. Note that only 4 YOY BOTO were caught at this site.

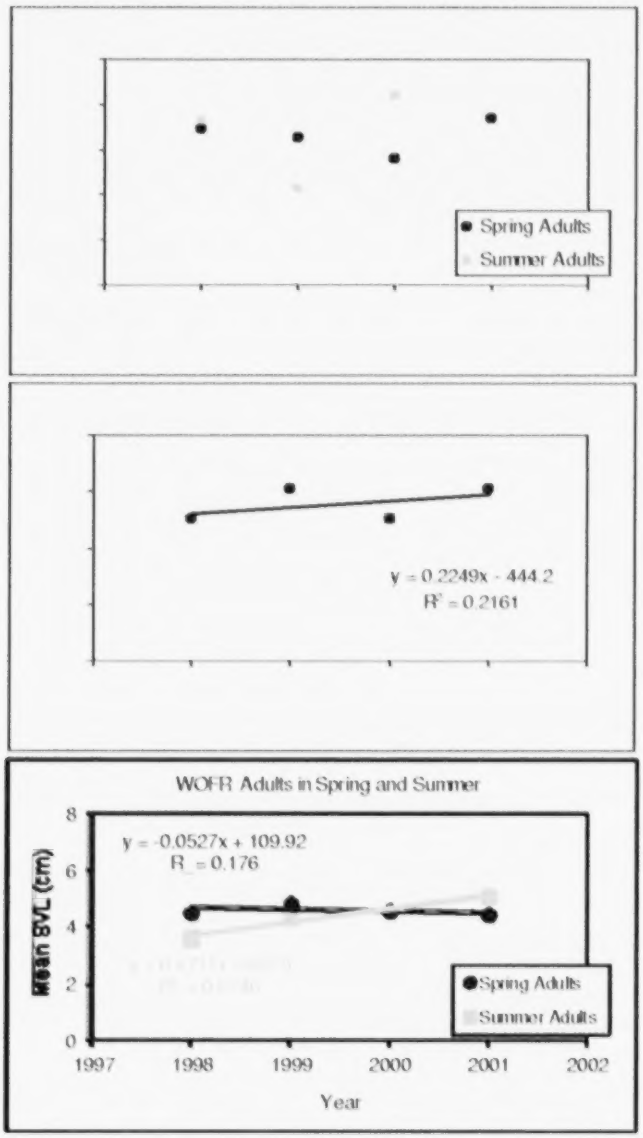

Figure 22. Trends in SVL over time at Kananaskis1. Note that YOY were only captured in one year for BOTO and LTSA, and in two years for WOFR, so no analysis of trend was possible for YOY size.

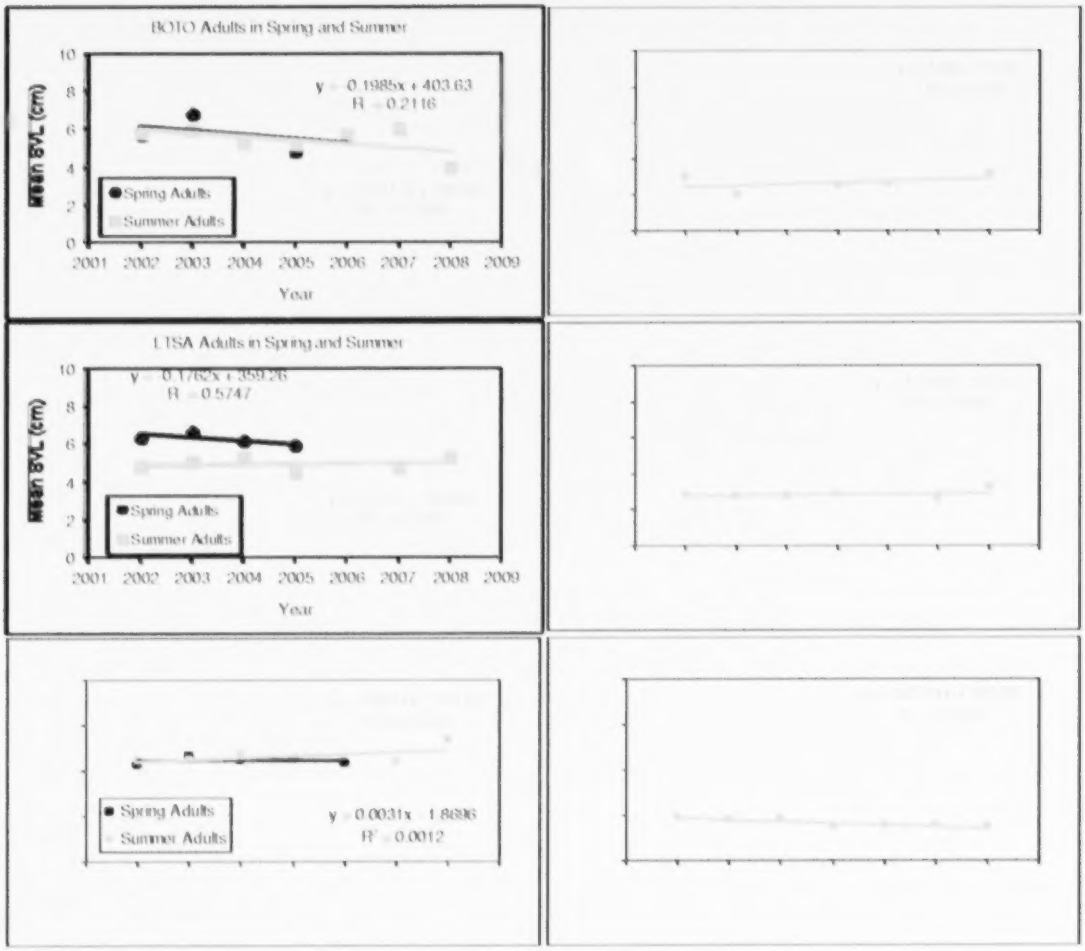

Figure 23. Trends in SVL over time at Kananaskis2.

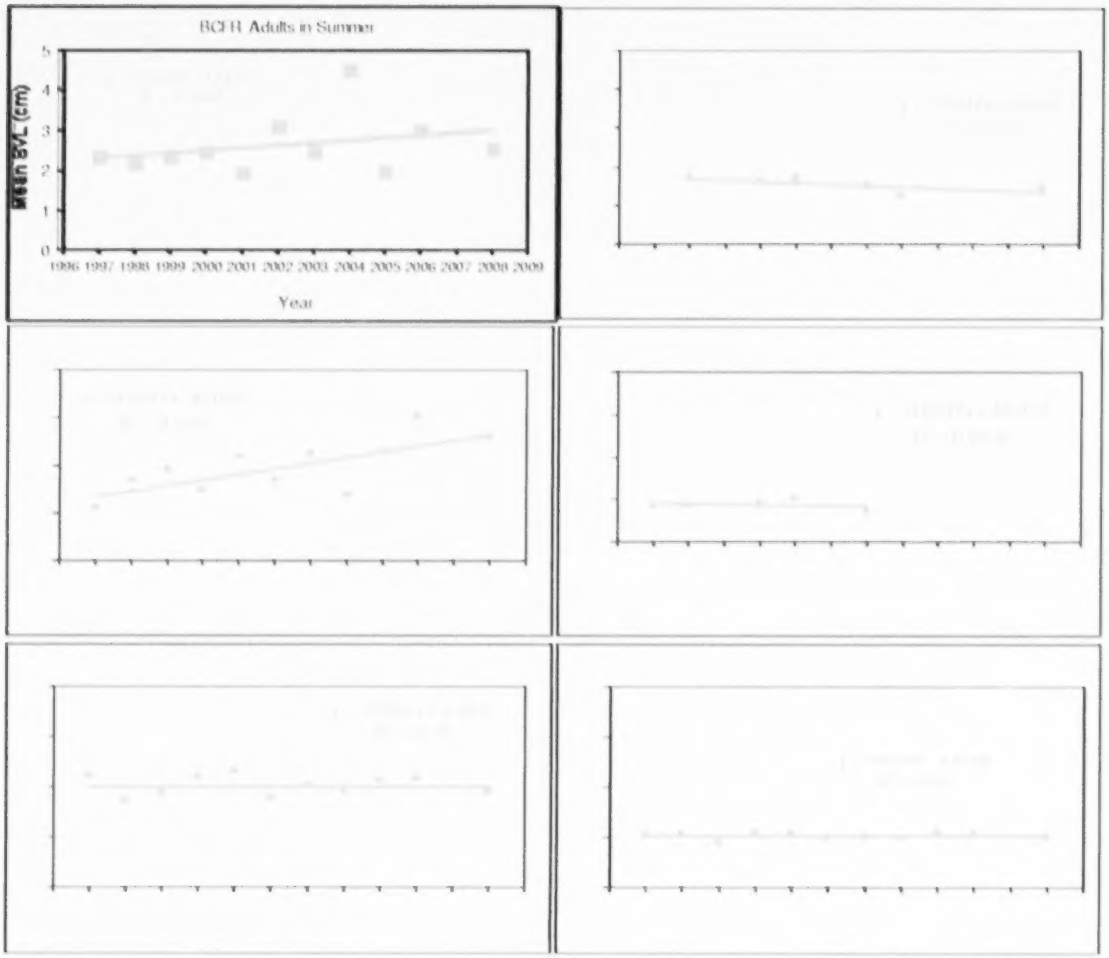

Figure 24. Trends in SVL over time at Meanook. Note that there was no Spring trapping at this site.

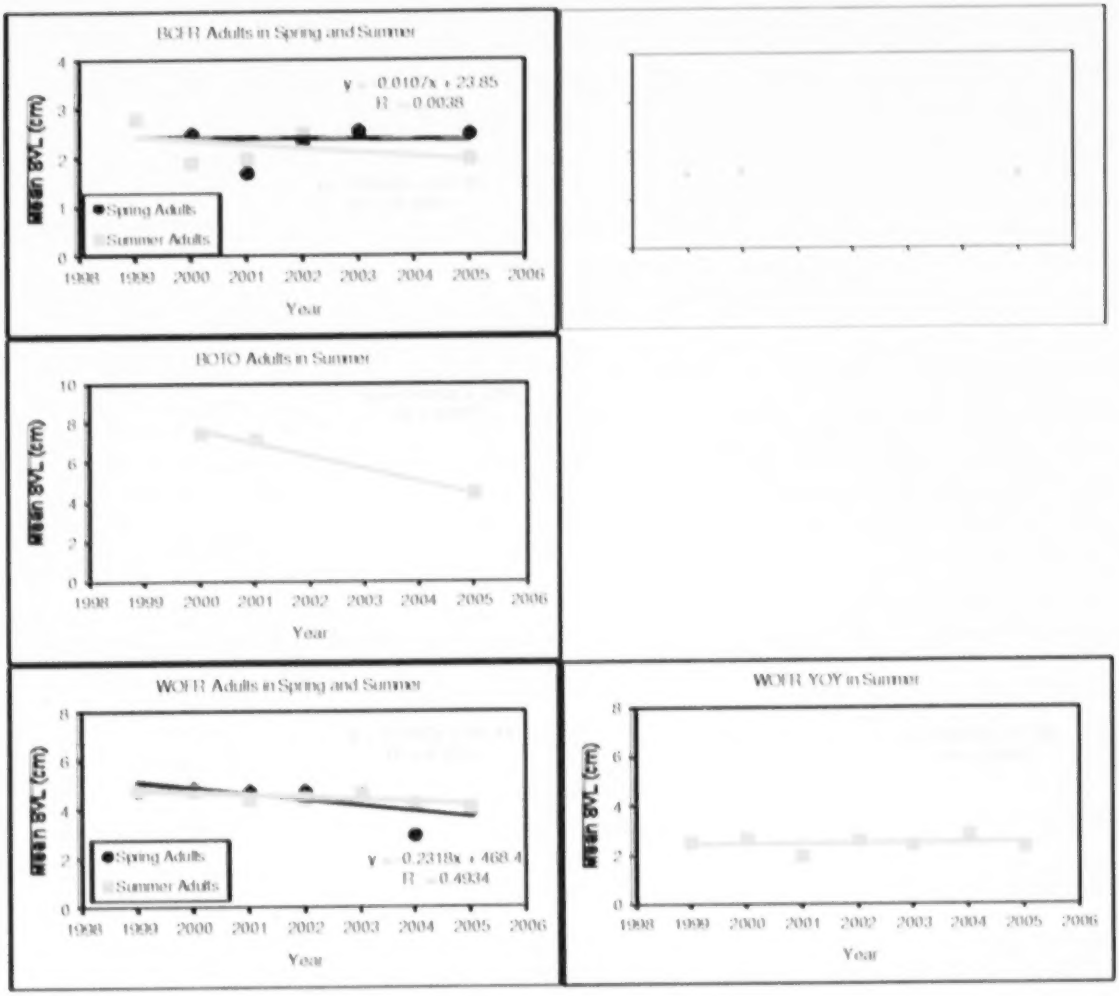

Figure 25. Trends in SVL over time at Saskatoon Island. Note that no BOTO YOY were captured at this site.

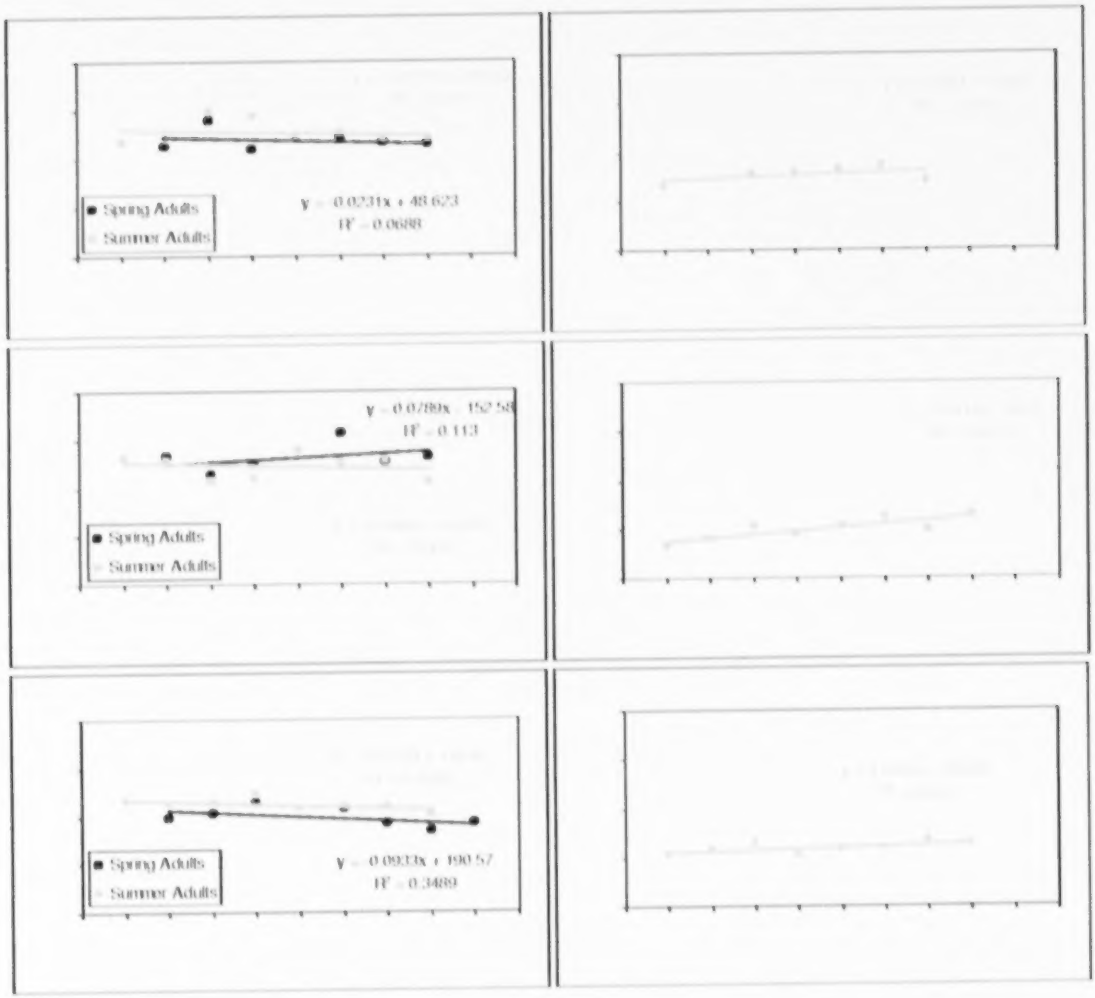

Figure 26. Trends in SVI over time at Lesser Slave Lake.

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